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Consumer Involvement with Smart Grid and Home Energy Generation

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Report Submitted to:

Professor Lorraine Higgins

Copenhagen, Project Center

By

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In Cooperation With

The Danish Consumer Council



CONSUMER INVOLVEMENT WITH SMART GRID TECHNOLOGY AND HOME ENERGY GENERATION

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This project report is submitted in partial fulfillment with the degree requirements of Worcester Polytechnic Institute. The views and opinions expressed herein are those of the authors and do not necessarily reflect the positions or options of the Danish Consumer Council or Worcester Polytechnic Institute.

Authorship

Paul Malmsten

This author wrote the “Learning about Prosumerism” and “What Consumers Know and Don’t Know” sections in the Results and Discussion, and he also wrote similar sections in the Recommendations and Conclusions section. He collaborated with his teammates to write the Background and Methodology sections, and helped edit his teammates’ work on other sections.

Throughout this project, I learned how to write survey questions and analyze its responses under the mentorship of the Danish Consumer Council. I also faced and conquered my discomfort with making cold calls to potential contacts for our research. Finally, I learned how to collect, analyze, and organize results for inclusion in a formal research paper.

Katharine Mims

This author wrote the “Incentive Program Details”, “Consumer Motivations”, “Consumer Reasons for Non-Adoption” and “Estimating Costs and Payback Periods” sections in the Results and Discussion, and she also wrote similar sections in the Recommendations and Conclusions section. She collaborated with her teammates to write the Background and Methodology sections, and helped edit her teammates’ work on other sections.

Throughout this project, I learned how to communicate with people better on a global level. I also learned the various elements and structures of conducting a consumer research study. I faced and conquered insecurity when gathering information from people where English is their second language, as I am often afraid of not hearing them correctly. I was able to work well with interviewees and clarify when needed. I also learned to analyze and compile various types of research information.

Peter Aspinwall

This author was responsible for writing “The Prosumerism Experience” under the Results. He also wrote the section “More Independent Information is Needed” under Recommendations. All group members had equal writing and revisions in the Introduction, Background, and Methodology, and Conclusions. He was also responsible for the organization of the IRB proposal. All interviews were conducted by all group members and survey questions were written and co-edited by the group as well.

From this project, I learned the most about organizing interviews and conducting surveys. Organizing interview responses into a usable data source was also an important take away from this project. I also learned important presentation skills in a technical setting that I can apply in my last year of school. I also learned valuable group dynamics that I can apply to future projects in my career and the rest of my time as a student.

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Abstract

We summarize the Danish residential solar photovoltaics and small wind turbine market from a consumer perspective for the Danish Consumer Council. We draw on background research, interviews, information sessions, and a consumer survey to learn about consumer motivations, deterrents, and challenges. Consumers are motivated by money savings, deterred by upfront cost, and challenged by technical information, but find the process easy overall. Incentive programs and independent information deserves additional research.

Executive Summary

The goal of this project was to create a comprehensive report on Danish consumers' opportunities, perceptions, motivations, and experiences with installing photovoltaic solar panels or a small wind turbine on their homes. Our report was commissioned by the Danish Consumer Council, such that they could more effectively represent consumers' interests in policy making efforts and advise consumers.

To this end, we identified the following research questions to address:

- How is information concerning the purchase and installation of solar panels and small wind turbines presented to consumers in Denmark?
- What motivates or discourages Danish consumers from installing solar panels or a small wind turbine?
- For those who have already installed solar panels or a small wind turbine, what were their experiences—how did they learn about, select, and install the equipment?
- What regulations and incentive programs currently influence the market for solar panels and small wind turbines in Denmark?

We began our project by researching the market for solar panels and wind turbines throughout the world. From this research, we learned about existing incentive programs that promote the use of solar panels or small wind turbines in the home, the factors that most commonly motivate and discourage consumers from installing them, and some of the technical implications of these systems for consumers and energy distributors alike. We leveraged this information to devise a list of stakeholders in Denmark to consult for additional information.

Upon our arrival in Denmark, we gathered information in three ways:

- We arranged interviews with a variety of stakeholders: 3 non-government organizations with a perspective on renewable energy; 3 retailers and installers of solar panels and/or small wind turbines, 2 government organizations, and 1 electricity distributor
- We also conducted in-depth interviews with 6 consumers who installed solar panels on their home, 5 consumers who installed a wind turbine near their home, and 3 consumers who had not installed solar panels or a small wind turbine on their home.
- In cooperation with the Danish Consumer Council, we supplemented this data on consumer attitudes and experience with a large scale survey of 970 Danish consumers
- Finally, we attended and observed consumer 2 information sessions that were arranged by solar panel and wind turbine retailers

We then condensed our consumer data into a set of lessons learned; these were organized by each step a consumer might follow when purchasing and installing solar panels or a small wind turbine: How they learn about these opportunities, what they know and do not know about them, their motivations and deterrents, and, for those who actually purchased the equipment, how they chose, installed, maintained, and assessed the performance of their installation.

Consumers usually first hear about the idea of installing solar panels or a small wind turbine on their home from broadcast media or people they know. While most seek additional information by talking to “experts” or going online, the sources they consult are often the retailers or installers, not independent experts who can provide unbiased information on equipment quality and pricing.

Most people understood the general concept of generating their own electricity to save money, but found it difficult to understand the technical details of the equipment and government incentive programs. Many people indicated that they did not know enough to assess their opportunities in the market.

In terms of taking action and actually making the decision to install, we found that the finances of the investment were by far the most significant motivating factor; consumers were motivated by the idea of saving money in the long term, and deterred by the upfront costs of an installation, which averaged about 100,000 DKK (20,000 USD) for a 6 kW solar array and 300,000 DKK (60,000 USD) for a 6 kW turbine. We also found that the benefits to society and the environment motivated some consumers, and some of the more technically-minded did it simply for fun. Due to the long community approval process and significantly higher price associated with small wind turbines, solar panels are much more popular in Denmark.

Consumers who decide to install then face the challenge of selecting and installing equipment for their home. Consumers tended to select equipment that would produce as much as they consumed annually and seemed to be of good quality. They selected installers by the equipment they sold as well as how dependable consumers perceived them to be, usually relying upon word of mouth. However, consumers found it difficult to ascertain the quality of solar panels and small wind turbines due to the lack of unbiased information and testing. Installing equipment was straightforward, however, requiring a few days for solar panels but longer--4-6 months-- for small wind turbines. Wind turbine installations required additional time to complete a lengthy community approval process. Finally, some people found it difficult to understand the technical implications of selecting a particular inverter.

The consumers we interviewed had their equipment for an average of one year; most were satisfied with the performance of their equipment. However, some reported problems with their inverters or unexpectedly turbulent wind in their area.

Our discussions with installers, energy companies, and other non-government organizations in the area also yielded important information, especially about the government incentive programs in Denmark for people who contribute electricity to the grid.

We conclude:

- Consumers are very interested in solar, but upfront costs and lack of knowledge are big deterrents. Other countries have provided ways to address this, such as low-interest loans, but these are not available in Denmark.
- When searching for detailed information, consumers tended to reference information provided by equipment retailers and installers. These sources are biased, and this is reflected in consumer interactions with them.
- We initially expected that energy producers and distributors would be more enthusiastic about and promote renewable energy generation, but they are still investigating the impact of many small energy sources on grid infrastructure. Instead, individual consumers and equipment retailers, who are very interested in the profitability of the venture, lead promotion efforts alongside environmentally-minded non-government organizations.
- Consumers are less knowledgeable about and less interested in wind turbines. The larger upfront cost required and strict and lengthy site approval process are significant deterrents, unless one consumes enough electricity or has enough space to scale up.

We end with two recommendations. Firstly, the government incentive programs as they currently stand in Denmark may cause some problems as the popularity of residential solar panel installations continues to grow. The current policy of net metering allows people who contribute electricity to the grid to withdraw

an equivalent amount of energy at a different time at no cost. This system causes a loss of revenue for energy providers and the government because consumers do not pay distribution fees and taxes on the electricity they withdraw. This is particularly troublesome because these losses are tied to the market value of electricity at any given time, which cannot be adjusted.

An alternative feed-in tariff policy has been proposed to address these issues. This tariff differs from net metering by paying consumers a fixed rate beyond the base value of electricity for the energy they produce. Consumers are still expected to purchase the energy that they use, but the income they generate from the feed-in tariff offsets this cost. The effect of such a policy on a Danish consumer's perspective of the market is unknown. We suspect that a policy like this may make it easier for consumers to estimate the payback period of an investment, a key area of confusion for many of them, but may also deter consumers who see the net metering program as insurance against rising electricity prices.

Secondly, we see it as problematic that little independent and unbiased information on quality, pricing, and technical details of solar panel and small wind turbine installations is available. Our interview participants expressed desire for more information about these issues in particular. However, the recent DK Energy Agreement of 22/3/12 calls for the closure of Go Energi, the primary source of independent energy saving advice and appliance quality testing in Denmark. This will make it even harder for consumers to find the unbiased information that they need.

Introduction

Global energy use is becoming an increasing concern as nations around the world gain prosperity and consumer electricity use continues to grow. As reported in the *World Energy Outlook*, the International Energy Agency (IEA) estimates that world energy consumption will rise 60% by 2030 (2004). In *Gadgets and Gigawatts* (2009), the IEA projected energy demand from consumer electronics alone will triple in that same period, adding to the already strained electricity grid. This growth has significant ramifications for world climate change. As it stands, the vast majority of the world's energy is supplied by burning fossil fuels. Under the projected energy demand of the future, the supply of fossil fuel will become increasingly scarce and its continued use will be destructive to the global climate (Solomon, 2004). To address these problems, people around the world are seeking new ways to produce energy cleanly and sustainably. In particular, there is growing interest in the energy production community for consumers to install solar panels or household wind turbines to contribute energy to the electrical grid.

Denmark, recognizing the future scarcity of fossil fuel and projected climate change, is taking a bold move to secure its energy interests. Denmark's ambitious *Energy Strategy 2050* has laid the political groundwork for a nationwide transition away from fossil fuel and towards complete energy independence by 2050. In order to accomplish this goal, significant investments must be made by both government and consumers alike to realize the full potential of alternative energy sources. Denmark is already a world leader in wind turbine research and development; in 2009, the IEA reported in their *Energy Statistics for Denmark* (2009) that 18% of Denmark's electrical energy needs were supplied by harnessing wind power. Wind power is expected to become a significant part of Denmark's energy portfolio through continued public and private interest. Solar electricity has played a much less significant role in Denmark so far, supplying a negligible (less than 1%) of overall electrical demand in 2009 ("IEA Energy Statistics for Denmark", 2009). "Small wind" refers to home-generated wind power installations rated for less than 25 kW of capacity. Although Denmark has many large wind operations, small wind accounts for a negligible portion of electricity generation, but has been growing globally at a rate of about 35% each year (WEA, 2012). This leaves much potential unharnessed, particularly in terms of residential participation. One way Denmark can contribute to Energy Strategy 2050 is to encourage the installation of solar and wind energy equipment at the residential level.

"Prosumers" are consumers who generate their own electricity through renewable sources and who contribute their excess energy generated back to the grid. Their contribution can decrease the use of fossil fuels and save on their energy bills. Currently in Denmark, there are few programs which incentivize or promote prosumerism, however the current infrastructure supports net metering, a policy mandated throughout Denmark, which is designed to reward consumers for contributing back to the grid. A consumer only pays the difference between the energy they consume and that which they produce. If more energy is supplied than consumed, the consumer is paid by the utility for that energy. Other countries such as Germany, Australia, Japan and Sweden have doubled or tripled residential solar panel installations by offering additional benefits like subsidies, credits, feed-in tariffs, tax breaks or other financial assistance (Ahm, 2011). Government incentive programs and tax subsidies could be used in Denmark to increase consumer motivation towards renewable energy equipment. Understanding what prevents consumers from becoming prosumers and what motivated existing prosumers to become active in energy production is imperative to devising appropriate incentives.

The Danish Consumer Council would like to represent and advise consumers on this topic, including types of options, costs, benefits, and drawbacks of solar and small wind systems, but it doesn't have the information that it needs to do so effectively. Although studies in other countries have discovered some of the most common motivators and barriers to prosumerism (Caird, 2008), but the Danish Consumer Council does not know of Danish consumers' perspectives, interests, and opportunities on the topic.

Our project aims to address this lack of knowledge. We will collect information about prosumerism in Denmark and compile a summary report for the Danish Consumer Council, such that it can understand the prosumerism sector and advise consumers about their opportunities. This will be accomplished by interviewing government organizations, energy companies, solar and wind equipment manufacturers and installers, consumers and prosumers. We will also document existing approaches to promoting residential microgeneration.

Background

In this chapter, we introduce the fundamentals of the electrical grid and outline the smart grid in Denmark. We also identify the major stakeholders who are involved with home energy generation which lead us to the specific groups and people we would later contact once on site. We then examine the available incentives for promoting wind and solar microgeneration around the globe. We also review information on consumer attitudes towards solar and small wind energy generation in other countries. These studies provide a context for the research we collected specifically on Danish energy policy and incentives as well as Danish consumer and prosumer attitudes about prosumerism.

Understanding the Electrical Grid

The electrical grid was developed with the intention of distributing electricity from central power plants to consumers. As electricity production plants are large, electricity grids often span large regions. Electrical energy can be generated through a variety of means. Coal, oil and natural gas power plants are the most common, though alternatives like hydroelectric, nuclear, solar, and wind power are gaining popularity due to their smaller environmental impact. In Denmark, there are sixteen central power stations, twenty three large substations, five converter substations and thousands of wind turbines (Energinet.dk, 2012). The Danish electrical grid also imports and exports energy to Sweden, Germany and Norway to support each other's needs. Norway specifically is a large contributor to the Danish electrical grid, and uses its hydroelectric power generation to supply energy as needed to Norway and Denmark. To support the energy needs of the future however, multiple sources of energy from both residences and power plants must work together to supply energy to the masses. Many promising technologies developed with the intention of modernizing the electrical grid are collectively called "the Smart Grid".

What is the Smart Grid?

A smart grid is an electrical grid network, which utilizes information about the usage and distribution of electricity to improve the efficiency of overall electricity use and production. The grid stores information supplied by new technologies such as smart meters, smart distribution centers and real-time sensors to monitor the production, flow and use of electricity. The data collected on a specific consumers energy use can be provided on the consumers' electricity bill. The bill will state the amount of usage, the times at which electricity is was used, and the amount of energy contributed back to the grid. This gives consumers better information about their energy usage such that they can adjust their behavior. Utilities can also encourage consumers to use less energy during times of high demand by offering incentives.

In a smart grid system, several power plants generate energy, which is distributed to households and businesses via distribution centers (Figure 1). A major goal of the smart grid is to allocate electricity usage evenly across the day and thus reduce the amount of on-peak usage. One method is a consumer's ability to contribute electricity back to the grid using technology such as photovoltaic solar panels or small wind turbines. By contributing back to the grid, consumers reduce their demand on the grid and assist in the mitigation of peak demand.

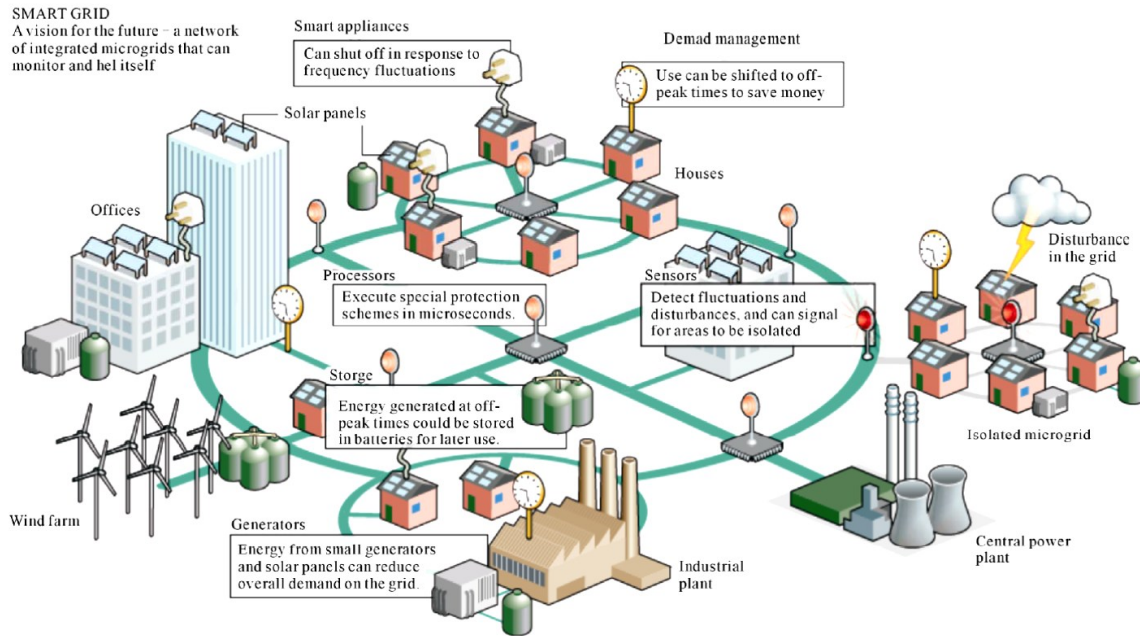


Figure 1: Demonstration of a Smart Grid Network (EcoGrid EU, 2012).

Microgeneration and the Emergence of Prosumerism

Prosumerism offers unique advantages for consumers and utilities alike. For example, many utilities are adopting the policy of net metering. For example, when a residence's microgeneration equipment generates more energy than the residence requires, perhaps when its occupants are away during the day, the excess energy is directed into the electrical grid and runs the meter backward. At the end of the billing period, the consumer pays only for the net energy amount of energy consumed from the grid. The consumer can be paid by the utility if they produce more than they consume during a billing period. The grid does not tax consumers for the energy they produce.

Utilities also benefit from the installation of this equipment. If many homeowners installed microgeneration equipment, the overall demand that a utility would have to support would be significantly reduced by the contribution of each residence. This lends the utility more flexibility in maintaining their infrastructure; less demand on the grid extends the life of the plant and decreases the likelihood of needed expansion to fit the grid's electricity needs.

Incentives for Photovoltaic Energy Generation around the Globe

Many different types of incentives are used to encourage prosumerism. Table 1 describes a variety of programs that motivate consumers financially towards using PV technology. Many of these incentive types can also be applied towards home wind energy generation.

Table 1: Types of Photovoltaic Incentive Programs used around the Globe (Ahm, 2011).

Incentive Name	Explanation
Enhanced Feed-in Tariff	An explicit monetary reward is provided for producing PV electricity; paid (usually by the electricity utility) at a rate per kWh somewhat higher than the retail electricity rates being paid by the customer
Capital Subsidies	Direct financial subsidies aimed at tackling the up-front cost barrier, either for specific equipment or total installed PV system cost
Green Electricity Schemes	Allows customers to purchase green electricity based on renewable energy from the electricity utility, usually at a premium price
PV-Specific Green Electricity Schemes	Allows customers to purchase green electricity based on PV electricity from the electricity utility, usually at a premium price
Renewable Portfolio Standards	A mandated requirement that the electricity utility (often the electricity retailer) source a portion of their electricity supplies from renewable energies (usually characterized by a broad, least-cost approach favoring hydro, wind and biomass)
PV Requirement in RPS	A mandated requirement that a portion of the RPS be met by PV electricity supplies (often called a set-aside)
Investment funds for PV	Share offerings in the private PV investment funds plus other schemes that focus on wealth creation and business success using PV as a vehicle to achieve these ends
Income Tax Credits	Allows some or all expenses associated with PV installation to be deducted from taxable income streams
Net Metering	In effect the system owner receives retail value for any excess electricity fed into the grid, as recorded by a bi-directional electricity meter and netted over the billing period
Net Billing	The electricity taken from the grid and the electricity fed into the grid are tracked separately, and the electricity fed into the grid is valued at a given price
Commercial Bank Activities	Includes activities such as preferential home mortgage terms for houses including PV systems and preferential green loans for the installation of PV systems.
Electricity Utility Activities	Includes 'green power' schemes allowing customers to purchase green electricity, large-scale utility PV plants, various PV ownership and financing options with select customers and PV electricity power purchase models.
Sustainable Building Requirements	Includes requirements on new building developments (residential and commercial) and also in some cases on properties for sale, where the PV may be included as one option for reducing the building's energy foot print or may be specifically mandated as an inclusion of the building development

Some of the more successful programs have been implemented in countries such as Japan, Australia and Germany. In 2010, Japan installed a total of 991 MW of mainly residential PV power. Peter Ahm, a researcher for the IEA, stated that currently residential PV accounts for 81.4% of the “grid-connected” photovoltaic energy market in Japan (2011). As described in *Trends in Photovoltaic Applications*, the installations were driven by a government subsidy for residential PV systems in which the electrical grid would purchase surplus PV electricity at twice the retail electricity price when the PV systems were less than 10 kilowatts in capacity (Ahm, 2011). The Japanese government plans to continue their incentive programs.

Australia increased their PV electricity installations from 67 MW in 2009 to 378 MW in 2010, where 99% of their installed solar is grid-connected, through government incentive programs such as the Solar Home and Communities Plan, Solar Credits and feed-in tariffs (Ahm, 2011). The Solar Home and Communities Plan offers rebates to consumers who purchase photovoltaic systems, for up to \$8,000 dollars, which resulted in over 130,000 residential and community solar system installations (Department of Climate Change and Energy Efficiency, 2011). The solar credit program, sponsored by the Australian government, applies a solar credit for an estimated amount of energy generation per year and multiplies the number of credits by a base amount of thirty dollars; this usually results in thousands of dollars' worth of credit (Origin Energy Australia, 2012). An example of this system is shown in Table 2. Based on the location, different numbers of STC credits are awarded per amount of kilowatts installed. Feed-in tariffs, one of the most common incentive programs, (FITs) are designed to reimburse the consumer for electricity that is provided to the electrical grid. Many countries including Italy, Germany, Malaysia, Portugal and Switzerland have experienced success with using FITs.

Table 2: Example Solar Credit System in Australia (Origin Energy Australia, 2012).

Example Location	STC Credit	Total Credit
Sydney, Brisbane, Adelaide, Perth, Canberra, Townsville	93 STCs x \$30 = \$2,790	\$2,790
Melbourne, Hobart	79 STCs x \$30 = \$2,370	\$2,370

In Sweden, the government provides subsidies on the installation, material and labor costs associated with PV systems. 222 million SEK or 188 million DKK has been reserved for the subsidy between 2010 and 2013. Fees associated with the distribution system operators for installing smart metering devices have been eliminated and FITs have been introduced under which PV electricity is bought by a local electricity utility for a higher price than the normal market value. Sweden had a total of 2.7 MW's of installed PV power as of 2010, tripling their PV capacity from 2009 (Ahm, 2011).

The United States has utilized various tax credit programs to increase consumer involvement in PV energy generation, such as the 30% investment tax credit which allows residential consumers to sell their generated PV electricity to third party aggregators who then sell the electricity to utilities. This program also allows PV installed between 2009 and 2012 to receive a grant reward of 30% of the cost of the PV project (Ahm, 2011). The Department of Energy Loan Programmes Office also offers low interest loan guarantees for PV power-generation projects, making the purchase of solar panels more cost effective in the long term.

These programs have resulted in many additional PV system installations, and their implementation in Denmark could yield similar results. Many countries have various incentive programs for grid-connected PV (Table 3). The types of subsidies and which countries they are implemented in are marked by X's, as well as the amount of feed-in tariff paid to prosumers per kilowatt hour of energy produce. Out of twenty countries, Denmark is tied with Malaysia for the third country with the fewest number of incentives for energy producing consumers. As stated in a National Survey report of PV Power Applications in Denmark, "Grid connected PV applications are seen as the largest potential (for photovoltaic integration) in Denmark, in particular building integrated applications on single family houses, apartment buildings,

commercial and office buildings” (Nowak, Stefan 2011). By increasing financial incentives for Danish consumers, the number of prosumers involved in PV energy generation can be increased.

Table 3: Incentive Programs by Country (Ahm 2011).

Types of Subsidies	AUS	AUT	CAN	CHE	DNK	DEU	ESP	FRA	ISR	ITA	JPN	KOR	MEX	MYS	NLD	NOR	PRT	SWE	TUR	USA
Enhanced Feed-In Tariffs USD	55g, 55n	50	77.9	38.7 - 71.0g		37.8 - 51.5	42.4	76.9	X	45.5 - 61.9	54.7n	X			X		X	X		X
Direct Capital Subsidies	X	X		X		X		X		X	X	X		X	X			X		X
Green Electricity Schemes	X	X	X	X		X	X			X	X									X
PV-Specific Green Electricity Renewable Portfolio Standards (RPS)	X		X								X	X						X		X
PV Special Treatment, in RPS	X										X									X
Investment Funds/ Finance Schemes for PV			X			X	X					X								X
Tax Credits			X	X				X			X			X	X		X			X
Net Metering/Net Billing	X	X	X	X	X	X				X			X	X	X					X
Commercial Bank Activities	X					X			X		X				X		X		X	X
Electricity Utility Activities	X		X	X	X	X	X				X							X		X
Sustainable Building Requirements	X		X	X	X	X	X					X			X		X		X	X
Inactive Household Retail Electricity Price USD cents/kWh	11.9 - 21.1	23.7	7	15.4	35.6	31.6			12.8	22.4	20.4 - 27.5	13.3 - 19.6	9	up to 14	28.8	11.6 - 14.9		23.6	17.5	11.58

Research Projects and Incentive Programs for Photovoltaic Integration in Denmark

EcoGrid EU, a European Union funded project, is conducting the first fully intelligent and 100% renewable power consumption system on the island of Bornholm in Denmark. The goal of EcoGrid EU is to “create ‘win-win’ situations, enabling small and large electricity consumers to save money on their electricity bill, while the power system is relieved” (EcoGrid EU, 2012). There are over 28,000 people living on the island with 2,000 directly participating in the study. The program is focused on integrating all types of renewable energy resources, ranging from wind, solar, wave, biogas, and heat pump energy generation as well as asking the public to contribute to energy storage using electric vehicles. In terms of solar technology on the island of Bornholm, a secondary initiative, separate from EcoGrid, called PVIB or Photovoltaic Island Bornholm is aimed at increasing photovoltaic installations on the island. “The PVIB

project is targeting MW corresponding to a PV penetration of 10% in the grid system of Bornholm” (EcoGrid EU, 2012). Denmark is also utilizing government funded research and development programs such as ForskVE to increase photovoltaic deployment and capabilities. ForskVE’s major goal is to promote the use of small-scale grid-connected energy generation technology. ForskVE has supplied the PVIB program funding of about 20 million DKK, of which will help the community reach the goal producing 10% of Bornholm’s electricity from photovoltaics (EcoGrid EU, 2012).

Another research project run by VKR Holding, an investment company, built an active house which contributes more energy to the grid than it consumes yearly. A family of five tested the home for fourteen months to evaluate the houses power production and consumption. As stated in the IEEE magazine *Spectrum* “Using ecologically benign materials, a rooftop of solar panels, and energy-scrimping designs, the house generates more than enough power to run itself” (Hansen, Ellen 2010). The company plans to complete eight more housing experiments similar to this one to promote home energy production and understand the challenges and benefits of living in a self-sustaining home. The results from these projects are not available yet to the public.



Figure 2: Net-Zero Energy Home in Aarhus, Denmark (Hansen, Ellen 2010).

Denmark has four types of incentives programs to make solar panels more affordable for consumers: net-metering with financial reward, energy footprint credits, grant opportunities and tax credits for solar panel installation costs (Table 4). Net-metering, a service supplied by the utilities, stipulates that the electrical meter run backwards when more energy is being produced than consumed by the consumer. For each billing period, the net amount of electricity used or contributed is calculated and the consumer is either billed or paid for their energy use. As stated in the Photovoltaic Power Systems Program Report, “Denmark has no general incentive for reducing the investment cost of PV systems but has a net-metering scheme set by law for private households and institutions. The net-metering scheme has become more attractive to consumers due to increasing taxes on electricity and the increased retail electricity prices. The photovoltaic market in Denmark is primarily driven by net-metering as illustrated by an annual market increase of 50% for photovoltaic installations from 2009 to 2011” (Ahm, 2011).

Table 4: Current Photovoltaic Incentive Programs for Consumers in Denmark (Nowak, 2011).

Type of Incentive	On-going measures	Measures that commenced during 2010
Enhanced feed-in tariffs (gross/net?)		
Capital subsidies for equipment or total cost		
Green electricity schemes		
PV-specific green electricity schemes		
Renewable portfolio standards (RPS)		
PV requirements in RPS		
Investment Funds for PV		
Income tax credits		
Net metering	Net metering	
Net billing		
Commercial bank activities (e.g. green mortgages promoting PV)		
Activities of electricity utility businesses	ForskVE programme for demonstration of PV	
Sustainable building requirements	Building codes	Building codes with planned future tightening

EnergiMIDT explains that other incentives, such as building credits, are from “The EU directive on energy consumption in buildings which specifically mentions PV and allocates PV electricity a factor 2.5 in the calculation of the ‘energy footprint’ of a building” (2012). The multiplier increases the amount of tax credits awarded for the construction of buildings and/or homes constructed with photovoltaics. Tax deductions are also awarded for the cost of labor associated with installing solar panels based on the hours of labor to complete the installation (EnergiMIDT, 2012). Grant opportunities exist via funding from the utilities, including a feed-in tariff on the electricity generated over a given amount of time. EnergiMIDT provides a 0.28 DKK/kWh subsidy for electricity produced by renewable energy (EnergiMIDT, 2012). These incentives are vital to help prosumers afford the initial costs associated with purchasing PV technology.

The government currently has little interest in solar generated electricity on any scale due to its low cost-effectiveness versus large wind power which is about 20 ore per kilowatt. Due to Denmark’s oceanic location and northern location, wind is of abundance while solar is less direct; however, Nowak explained, “In the longer term, photovoltaic solar modules and wave power could replace some wind power. At present they are more expensive than electricity from wind turbines. However, there may be technical and financial advantages in spreading electricity production between different technologies” (2011).

Electric Companies and Solar Panel Manufacturers in Denmark

Several electric companies are promoting renewable energy use at the individual consumer level in Denmark. EnergiMIDT provides consumers with information on how to purchase photovoltaics as well as other green energy sources, such as heating with wood chips or heat pumps for home heating. EnergiMIDT advertises the benefits of solar panels via their website:

Why you should buy solar cells

- With solar, you get a reliable energy source with minimal maintenance
- With solar, you get your own CO₂-neutral energy source
- With solar panels reduce your monthly electricity costs
- Solar cells can be harnessed to meet the energy envelope
- With solar cells run your electric meter "backwards" when production exceeds consumption
- With solar panels guarantee you a fixed price of solar power for the next 25 years

Figure 3: List of Reasons Given by EnergiMIDT for why Consumers Should Invest in Solar Panels (EnergiMIDT, 2012).

Solar cells in Denmark are rated for a lifecycle of about 25-30 years and require minimal maintenance to keep the panels clear of debris. Depending on the photovoltaic provider, storm damage inflicted upon solar panels may be insured. Solar panels can protect the roofs of homes and support the roof structure due to the structural equipment installed to hold the panels, and can be seen as architecturally and environmentally savvy in the Danish society. The financial incentive of reducing monthly electricity costs and fixing the price of electricity can be highly motivating, as electricity prices in Denmark have increased by 23% since 2007 and are expected to continue rising (Eurostat, 2012). Buying solar panels allows the consumer to have some electricity at a fixed price based on its initial cost for the lifespan of the panels. To simplify the costs of solar panel products for consumers, some utilities and companies offer solar panels in set packages and have a secondary option for specialty projects. EnergiMIDT also holds information sessions consumers can attend and maintains websites explaining currently existing solar projects such that consumers can fully understand the solar panel installation process.

EnergiMIDT provides a cost estimate of a solar panel package to demonstrate the various incentive packages available and the payback period for consumers (Table 5). The estimate is based on the average electricity price of 2 kronor/kWh for electricity from the utility company, an estimated amount of solar electricity produced, tax credit deductions, grants and the initial investment costs to calculate the payback period. Example cost calculations are important to help consumers understand the payback periods for solar photovoltaics and to estimate possible future electricity savings once the panels initial cost has been paid off.

Table 5: Example Solar Panel Cost Calculation by EnergiMIDT (EnergiMIDT, 2012).

Cost of Solar		Savings from Solar	
ALU 6.4 kWp	126,000 DKK	Electricity Prices	2 kr/kWh
Surface Area	41m ²	Effect of Solar	5,779 kWp
Tax Credits (Labor 22,800 DKK)	7,524 DKK	Savings (electricity price x power)	11,558 DKK
Grants (calculated from area)	1,476 DKK	Simple Payback	Approx. 10 years
Total Expenditure	116,959 DKK		

The manufacturers of solar panels in Denmark mostly target off-grid use, and sell solar panels ranging in electricity production from a couple of Watts to almost 200 Watts per panel. The manufacturers focus on off-grid to reduce the complication of the installation by avoiding interaction with the utilities and smart metering services, which would be involved in a grid connected installation. These panels are often employed to power irrigation systems or remote cabins for which connecting to utility power would be prohibitively expensive. Alternative methods of promoting and educating consumers were investigated upon our arrival in Denmark. The information we derived is provided in the Results chapter.

Incentives for Small Wind Energy Generation around the Globe

Home wind microgeneration is not as common as solar energy microgeneration because of the large wind industry monopoly on the wind energy market. Large wind is extremely less expensive per kilowatt generated than small wind, due to the mass production and government incentive programs for large wind. The World Wind Energy Association identified the major driving factors for the relative popularity of large wind as “the cost of the technology, the enactment of supportive policies and economic incentives, fossil-fuel prices, investor interest, consumer awareness, certification and quality assurance, permitting processes and regulations and wind evaluation tools” (WEA, 2012).

Some countries such as China and the United States have begun to offer incentives for small wind, including tax credits, feed-in tariffs and subsidies. By introducing these incentive programs, the American Wind Energy Association reported “the market for small wind systems grew 26% with 25.6 megawatts of annual sales representing 7,811 turbines” (WEA, 2012). Grid-connected turbines tend to be larger than off-grid turbines; on-grid systems accounted for 92% of all small wind energy generation capacity in 2010 (AWEA, 2012). The United States offers a 30% federal investment tax credit, and various states offered additional subsidies.

The World Wind Energy Association stated in their *Small Wind World Report 2012* that the United States, China, United Kingdom, Germany and Canada lead the world in small wind capacity (2012). The United States alone accounts for 40% of the global installed capacity of home generated wind power (WEA, 2012).

Current feed-in tariffs range from 3.19 DKK/kWh in Portugal, to a minimum of 0.60DKK/kWh (which is a lack of tax, not a direct feed-in tariff) in Denmark (WEA, 2012). The report forecasts that between 2000 and 2010, the installed solar energy capacity increased by 39%, and that the small wind industry is expected to follow the same trend; the World Wind Energy Association has already projected an annual 35% increase of installed capacity, as shown in Figure 4, though 2020 (WEA, 2012). The report notes, however, that “sales and production are still dependent on the magnitude of government incentives in the form of supportive policies or financial aid programs, and only a handful of countries offer sufficient supportive schemes” (WEA, 2012).

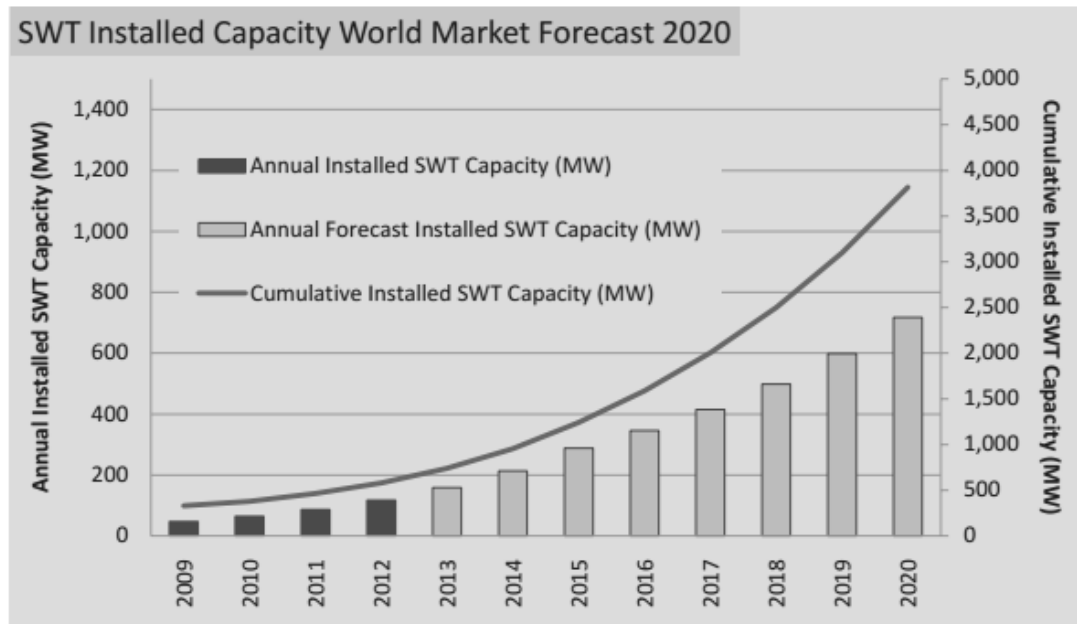


Figure 4: Installed Small Wind Capacity and Future Forecast for 2020 (WEA, 2012).

Current Research Projects and Incentive Programs for Small Wind Integration in Denmark

While the Danish government has been offering incentives for big wind turbines for over 30 years, it did not offer incentives for small wind generation until 2007. After recognizing the potential for renewable wind power at the residential level, the government was contacted by manufacturers interested in the market for small wind turbines. In 2008, the Danish government had established a number of incentives similar to those offered for photovoltaic solar panels on homes. The Danish Small Wind Turbine Association, formed in 2009, pushed additional incentives for small wind through parliament that same year (CITE HERE).

In 2008, the Danish Energy Agency established a new certification scheme for the design, manufacture, and installation of wind turbines (Justesen, 2008). Under these rules, all turbine installations were subject to certification which could cost as much as 70,000 DKK (12,500 USD) and require 6 months to complete. This additional cost and slow approval stifled the small wind turbine industry until 2010, when the Danish Energy Agency revised the certification requirements for small turbines. The DEA exempted turbines with a rotor area of less than 1 m² from the approval process entirely and streamlined the process

for turbines with a rotor area of less than 40 m² or a rated power of at most 25 kW. This policy revision, coupled with the established government incentives, recently made it easy and enticing for consumers to become small wind turbine owners. While turbines were subsidized before 2008, small wind turbine installations since then are eligible for additional compensation and tax exemptions. Incentives are also available from the Danish government for scrapping old small wind turbines in hopes that the consumer will erect new, more efficient small wind turbines.

Obstacles to Prosumers

Although governments and electric companies offer incentives for consumers to install small wind and solar panels, the move from consumer to prosumer can still be difficult. The United States National Renewable Energy Laboratory found several nontechnical barriers consumers face in utilizing solar panels, electricity efficiency (EE) and renewable energy (RE) technology in the United States (Figure 5):

- Lack of government policy supporting EE/RE
- Lack of information dissemination and consumer awareness about energy and EE/RE
- High cost of solar and other EE/RE technologies compared with conventional energy
- Difficulty overcoming established energy systems
- Inadequate financing options for EE/RE projects
- Failure to account for all costs and benefits of energy choices
- Inadequate workforce skills and training
- Lack of adequate codes, standards, and interconnection and net-metering guidelines
- Poor perception by public of renewable energy system aesthetics
- Lack of stakeholder/community participation in energy choices and EE/RE projects.

Figure 5: List of Barriers for Consumer Involvement with Energy Generation (Margolis, R. 2006).

Many of these issues exist in Denmark, although some have been addressed through government programs, including public perception of renewable energy, stakeholder/community participation, the Dane's history with renewable energy and standards for net-metering. The lack of government policy, financing options, consumer awareness, workforce skills, and the high cost of solar are all issues Denmark must address to promote prosumers. The Open University in the United Kingdom performed a study researching the reasons consumers in the United Kingdom do and do not adopt photovoltaics and small wind. The main reasons for non-adoption of photovoltaics and small wind are listed in Table 6. 85% of consumers they surveyed felt that solar panels were too expensive and 40% felt that the fuel savings were not worth the initial cost of the panels. The study stated "The main barriers to the installation of PV are capital cost and/or too long [of a] payback [period], but other deterrents included insufficient output, difficulties connecting to the National Grid, finding an installer or a suitable location" (Caird, 2008). Connecting to the grid and finding installers for net metering systems is not a common problem in Denmark, due to government regulations on smart metering equipment and eight utilities have installed over one million smart meters by the year 2009 (Shargal, 2009). Due to Denmark's similar weather patterns to the United Kingdom, the amount of energy produced by solar panels can be an issue depending on the amount of sunlight the country receives. "In Denmark there are 1800 hours of sunshine per year, the equivalent of which can produce 1000 kWh per m² per year on a horizontal surface, or 1250

kWh per m² per year on a south-facing roof with 45 degree tilt. It is roughly half of production in the Sahara” (Stenkjaer, 2009).

Table 6: Barriers for Adoption of Photovoltaics (Caird, 2008).

Main Reasons for Non-Adoption of Renewable Energy Technologies	
Barriers to Adoption	Solar Photovoltaics (Percent Response)
Too Expensive	85%
Likely Fuel Savings Not Worth the Cost	40%
Difficulty Finding a Good Installer	24%
System Not Likely to Last Long Enough to Pay Back	28%
New Technology With Uncertain Performance and Reliability	19%
Gaining Planning Permission	13%
Difficulty Finding Space or Suitable Location for Unit	16%
Insufficient Electricity Produced	28%

Some barriers for adopting small wind energy technology were identified by Gaia-Wind, a global small wind turbine manufacturer and installer (Figure 6) The various requirements including permits, good location, high home energy demand, a large initial investment and distances between surrounding neighbors can all pose challenges for consumers.

- You must have a zone permit. It costs nothing and you are not forced to use it if you get it. With the rural zoning permit will also get a permit to raise the mill.
- You must have a possible location for the mill with good wind conditions and so much open land in the front, in the direction of west-southwest.
- There must be some minimum distances to neighbors, churches, etc.
- You must have an appropriate high power consumption (over 20,000 kWh)
- You must have financial flexibility to prepay your energy consumption by investing approx. 400,000 DKK in a household mill.

Figure 6: Barriers of Small Wind Turbines (Gaia Wind, 2012).

53% of those surveyed in the The Open University study responded that small wind turbines were too expensive, 37% found it too difficult to gain planning/zoning permission and 33% had difficulty finding a place to put the unit (Table 7).

Table 7: Barriers for Adoption of Mirco Wind Turbines (Carid, S. 2008).

Barriers to Adoption	Micro Wind Turbine (Percent Response)
Too Expensive	53%
Likely Fuel Savings Not Worth the Cost	21%
Difficulty Finding a Good Installer	25%
System Not Likely to Last Long Enough to Pay Back	15%
New Technology with Uncertain Performance and Reliability	21%
Gaining Planning Permission	37%
Difficulty Finding Space or Suitable Location for Unit	33%
Insufficient Electricity Use	19%
Noise/Vibration	26%

The study also reported the main reasons for the adoption of PV technology (Table 8). The study showed that 56% of consumers who invested in solar panels did so because environmental concerns and another 43% because they had the money available to invest in solar (Caird, 2008).

Table 8: Main Drivers for Adopting Photovoltaics (Carid, S. 2008).

Main Drivers for Adoption of Renewable Energy Technologies	
Main Driver	Solar Photovoltaics (Percent Response)
Save Energy-Reduce Fuel Consumption	31%
Reduce Fuel Bills-Save Money	25%
Concern for Environment-Global Warming-Reduce Emissions	56%
Has Funds Available to Invest	43%
Received a Grant-Special Offer	25%

The study reported the main reasons for the adoption of small wind technology (Table 9). The study showed that 39% of consumers who invested in small wind based their decision on energy savings, 33% based on environmental concerns and 28% to save money on their electricity bill (Caird, 2008). Consumer motivations towards becoming prosumers are important for understanding how to promote prosumerism by analyzing what barriers have outweighed the drivers.

Table 9: Main Drivers for Adopting Small Wind (Carid, S. 2008).

Main Driver	Micro Wind Turbine (Percent Response)
Saving Energy – Reduce Fuel Consumption	39%
Concerns for Environment-Global Warming-Reduce Emissions	33%
Reduce Fuel Bills – Save Money	28%
To Try Out an Innovative Technology	22%
Received a Grant-Special Offer	17%

The European Commission performed a survey called the EuroBarometer - Attitudes towards Energy which surveyed European countries on their renewable energy views, including issues concerned with cost. The study stated that 59% of Danes thought more information on efficient energy use should be provided, 44 % of Danes thought that tax incentives should be developed to promote efficient energy use and 45 % of Danes thought that the government should focus on developing the use of solar power (European, 2006). 48% of Europeans thought the government should focus on solar power as a renewable energy resource to lower dependence on imported energy resources, and 33% thought the government should focus on wind (European, 2006). The survey also reported on whether people would be prepared to pay more for energy produced by renewables. In Figure 7 **Error! Reference source not found.**, Danish responses are shown in the top purple bar. The data illustrates that almost half Europeans would pay more for renewable energy over conventional energy; however, most wouldn't pay more than a 5% increase in cost. This result highlights that the installation costs and long pay back periods make investing in photovoltaics a non-viable option for consumers. The initial costs would make the cost of electricity from solar appear very high to consumers with a long time period before complete payback is achieved.

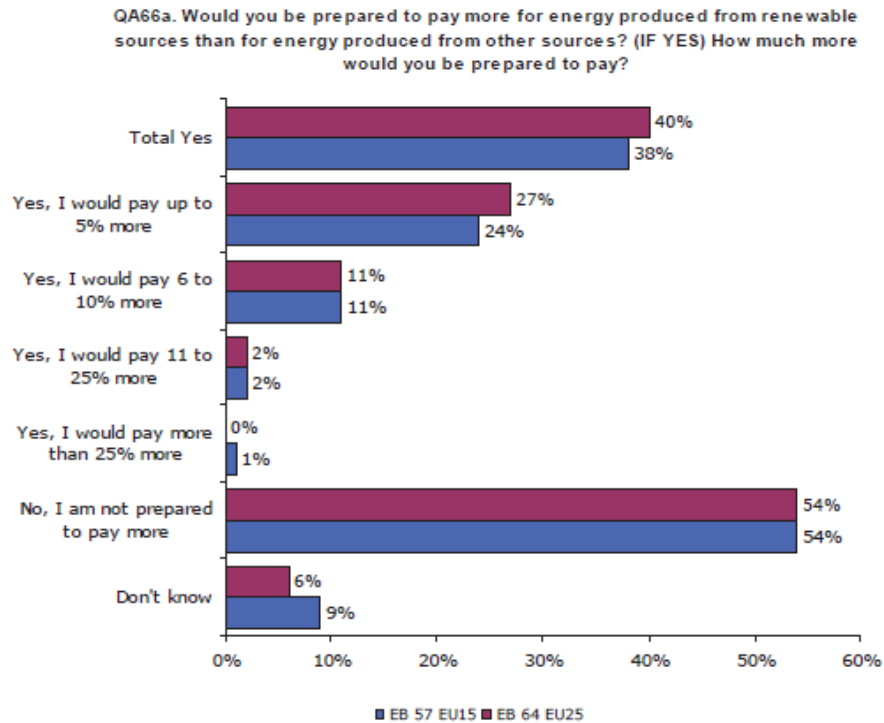


Figure 7: European Survey Responses on Paying more for Renewable Energy (European 2006).

The most common drivers across all studies for both small wind and solar panels were environmental stewardship and saving money on electricity bills. The most common barriers throughout the studies were that the payback would take too long and that solar and small wind is too expensive (Figure 8). The studies also expressed that a large percentage of Danes feel that increasing energy consumption from renewable sources is important should be supported by the government. In order to increase the adoption of solar panels and small wind, all barriers to adoption must be addressed, and reasons for adoption promoted.

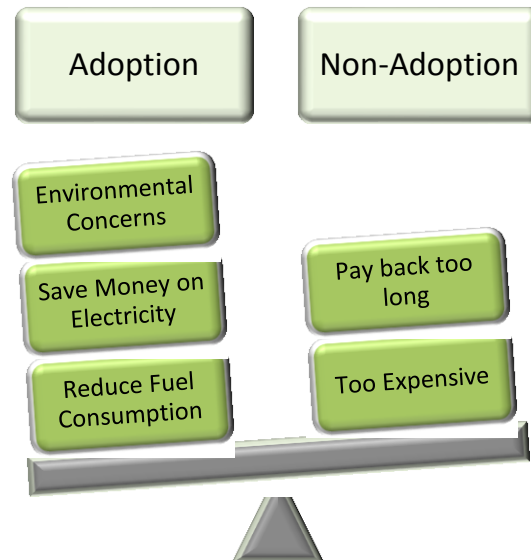


Figure 8: Common Reasons for Adoption and Non-Adoption of Small Wind and Solar Panels.

Government Institutions

The most prominent government institution in Denmark with an interest in the electrical energy sector is the Danish Energy Agency. Under the direction of the Ministry of Climate, Energy, and Building, the Danish Energy Agency is responsible for overseeing national and international energy policy for Denmark. In recent years, the agency has focused on improving the environmental friendliness of Danish energy sources as evidenced by Energy Strategy 2050, the national plan to move away from fossil fuel which the agency authored in 2011.

The Danish Energy Agency oversees two trusts which may be relevant to our topic: the Danish Energy Savings Trust and the Energy Technology Development and Demonstration Programme.

Danish Energy Savings Trust

The Danish Energy Savings Trust reduces energy demand in Denmark by informing energy consumers on how to conserve energy. The trust provides a website full of energy saving tips for residences and businesses as well as maintains its own product approval sticker program. Appliances that meet the trust's criteria for energy efficiency may display the trust's sticker.

Since the Danish Energy Savings Trust works directly with consumers to promote energy saving, it is likely to have a perspective on home solar panel use and the act of influencing consumer behavior that would be beneficial to our project.

Energy Technology Development and Demonstration Programme

Established in 2008, this program is tasked with promoting investment in new ways to generate clean energy in Denmark. Innovators may apply to the program to receive enough funding to demonstrate the new energy technology they envision. Through these grants, the program aims to stimulate investment and research in energy technologies that could become significant components in Denmark's future energy infrastructure.

Although less directly related to placing solar panels on residences, this program may be able to point us toward some of the latest research in the field of home energy generation.

Energinet.dk

Also under the direction of the Danish Ministry of Climate, Energy, and Building, Energinet.dk is an organization which owns and maintains the electrical and natural gas transmission lines throughout Denmark. As such, Energinet.dk's website provides specialized information about Denmark's electricity and natural gas networks as well as a real-time look at how energy is flowing through Denmark at any given time. In addition, the organization sponsors research on alternative energy sources, including solar, and how to effectively integrate wind energy into the electrical grid.

As the operator of transmission lines within Denmark, Energinet.dk is an excellent resource for information about how the grid operates as a whole and about what government actions might support large-scale renewable power generation at home.

Research Targets

The information gathered was used to identify potential research targets including government organizations, non-government organizations, solar panel and small wind installers and manufacturers, and consumers and prosumers. We explored our current knowledge further and gained a better understanding of Danish consumers and their experiences with home energy generation. By exploring these groups further, we provided information to the Danish Consumer Council such that they will now be able to better represent consumers and prosumers, and make recommendations or offer help in their involvement.

Methodology

Our objective is to supply the Danish Consumer Council with information such that they can accurately represent consumers and provide information on how consumers can become involved. To accomplish our objectives, we identified the following major questions:

- What are existing Danish prosumers' experiences with small wind and/or solar panel energy generation?
 - Why did they become a prosumer?
 - How did they become a prosumer?
 - How did they learn about the options for getting involved?
 - What steps did they take to implement their technology?
 - What challenges did they encounter in becoming a prosumer?
 - How have they benefited from becoming a prosumer?
- Why don't Danish consumers become prosumers?
- What regulations and incentive programs currently shape prosumerism in Denmark?
- How is information about becoming a prosumer presented to consumers in Denmark?

Each of these questions is multifaceted; government entities, non-government organizations, equipment manufacturers/installers, and residential consumers all have relevant perspectives. To reflect all of these perspectives, we surveyed 970 Danish consumers and arranged interviews with stakeholders.

Interviews

We contacted and completed interviews with the following organizations:

- Government Organizations
 - Danish Energy Agency
- Non-Government Organizations
 - Photovoltaic Owner's Association
 - Household Mill Owner's Association
 - EcoGrid - Borholm Island Project
 - Energy Service Bornholm
 - EcoCouncil
- Utilities
 - Dong Energy
 - EnergiMIDT
 - Danish Energy Association
- Manufacturers and Installers
 - TEKNordisk – Solar Installer
 - EcoWind – Wind Installer
 - Stenbaek Andersen – Solar and Wind Installer
 - Living Energy – Solar Installer
 - Gaia Solar – Solar Manufacturer
- Prosumers
 - Simon and Dina – Solar Prosumer
 - Valter – Solar Prosumer
 - Ronny – Solar Prosumer
 - John – Solar Prosumer
 - Egon – Solar Prosumer
 - Lars – Solar and Wind Prosumer
 - Stig – Wind Prosumer
 - Hugo – Wind Prosumer
 - Hans – Wind Prosumer
 - Steen – Wind Prosumer
- Consumers
 - Susanne – Solar Panel Neighbor
 - Irma – Solar Panel Neighbor

In addition to interviewing representatives from these organizations, we also asked them to refer customers who would be willing to interview with us. We also asked prosumers to connect us with non-prosuming neighbors who would be willing to interview with us. We valued the perspective of non-prosuming neighbors of prosumers because they would likely have already learned about options like solar panels or small wind from their neighbor, and yet they had chosen not to purchase the equipment for themselves, and thus be able to provide rich responses to our interviews.

Interviews were held over the phone, in person, or via email at the interviewees' convenience.

Potential interviewees were contacted informally about their interest in participating in our study. The following is an example introductory email that we sent (Figure 9).

Hej,

We are studying small (< 25 kW) residential electricity generation on behalf of Forbrugerrådet (Danish Consumer Council). We aim to learn more about homeowners' motivations for participating at a residential level as well as how they got started with microgeneration.

My partners and I would like to arrange an interview with you, by phone or in person, within the next few weeks.

Your involvement would be much appreciated. Please contact us by email at dk12energy@wpi.edu or by phone at 77 41 77 23 from 9.00-12.00 and 13.00-15.00 and let us know if this is possible.

Tak,
 Peter Aspinwall
 Paul Malmsten
 Katie Mims

Figure 9: Call/Email Example Introduction

The following key points were mentioned as we introduced ourselves to potential contacts:

- Who we represented (the Danish Consumer Council)
- What we wanted to investigate (residential prosumerism)
- Why we contacted them (to arrange an interview)
- How to reach us (Danish phone number and email were provided)

During the Interviews

We began the interviews by asking the participant if they would agree to the consent form (Appendix A).

We identified the following categories of participants:

- Prosumers
- Consumers
- Non-government organizations (NGOs)
- Government organizations
- Equipment retailers/installers
- Electrical utilities

In addition, each of these categories was further subdivided by equipment specialty, solar panels or wind turbines, and a set of questions was devised for each combination of category and equipment specialty. For participants with relevant knowledge in both equipment specialties were asked both sets of questions, one after the other. For example, an equipment installer organization that installed solar panels and wind turbines would be asked questions with a solar panel focus and questions with a wind turbine focus, one set after the other. Questions that exactly matched across equipment specialties were not asked twice.

Responses to interview questions were recorded via hand written or typed and organized with a notes sheet for each type of interview participant.

All of our question sets are available in Appendix A: Interview Questions.

Survey

In addition to interviewing prosumers directly, we also worked with the Danish Consumer Council to survey 970 of their constituents.

The survey, sent to consumers in Danish, provided an overview of consumer knowledge and interest in prosumerism by asking “select-one” or “select-all-that-apply” questions, which allowed us to leverage the large survey audience without being overwhelmed by variance in responses. We asked Danes about their living situation, knowledge of residential electricity generation, perspective on renewable energy, and important incentive and communication factors in their potential involvement in prosumerism.

The final version of the questions submitted to Danish consumers is available in Appendix B: Survey Questions.

Information Sessions

We also attended information sessions hosted by the following equipment retailer/installer organizations:

- Stanbaek Anderson – Solar and Wind Retailer/Installer
- EnergiMIDT – Solar Retailer/Installer

These information sessions were open to the general public and advertised on each respective organization’s web site. Although the sessions were conducted in Danish, we were able to gather some information from presentation slides and handouts. A colleague accompanied us from the Danish Consumer Council who translated parts of the presentations for us.

We attended the information sessions to gain a better understanding of important topics of discussion for consumers. We recorded the types of questions asked by the attendees as well as consumer reactions to question answers.

Results and Discussion

The goal of this report is to provide an overview of the home wind turbine and solar panel markets. To make our results easy to understand, we have modeled the structure of this section after the process that consumers follow when they decide to install solar panels or a small wind turbine. We have split this process into the following parts:

Learning about Prosumerism. Every potential prosumer must first learn about the opportunities available to them. In this section, we will how consumers first learn about prosumerism, where they find additional information, and the challenges they face.

What Motivates Consumer to Become Prosumers. In this section, we will discuss the reasons why some consumers decide to install solar panels or a small wind turbine, why some decide not to, and what the implications are for Danish society.

Consumers Reasons for Non-Adoption of Microgeneration. In this section, we will discuss the most common reasons why consumers chose not to invest in solar panels or a small wind turbine when they learn of the opportunity to do so.

Estimating Costs and Return. In this section, we will discuss the finances of an investment in solar panels or a small wind turbine.

Beyond this point, our findings are tied closely to each type of technology; solar panels or small wind turbines. Thus, the remaining sections are provided twice; once for solar panels, and once for small wind turbines.

The Prosumer Experience. The basic profile of an average solar and wind prosumer is described in this section. This section of the report is then broken into subsections sections described below.

Selecting an Installer. In this section, we will discuss how consumers select an installer and the challenges they face throughout the process.

Selecting Equipment. In this section, we will discuss how consumers select equipment, how they install it, and the challenges they face throughout the process.

Installing Equipment. In this section, we will discuss the installation process for solar panels or a small wind turbine and the challenges they face throughout the process.

Actual Performance and Maintenance. In this section, we will discuss the actual performance prosumers have observed from their equipment, what kinds of maintenance or upkeep is required, and whether or not their installation met their expectations.

Finally, we conclude with a summary of the incentive programs for generating electricity at home and the financial details consumers must be aware of.

Within each of these sections, we will list our key findings. We will support each finding with a holistic analysis of our stakeholder interviews, consumer survey results, and information session notes. Wherever reasonable, we will present our results from the perspective of a consumer.

Learning about Prosumerism

People tend to first hear about the idea of installing solar panels or a small wind turbine from broadcast media and people they know. This was evident in our survey results; 58% of our respondents mentioned these sources when asked about solar panels (Figure 10), and 39% of our respondents mentioned these sources when asked about small wind turbines (Figure 11). The internet and advertisements from dealers were also common ways that people first learned about the opportunity; the internet was a more common source for solar panel information, and advertisements were a more common source for small wind turbine information.

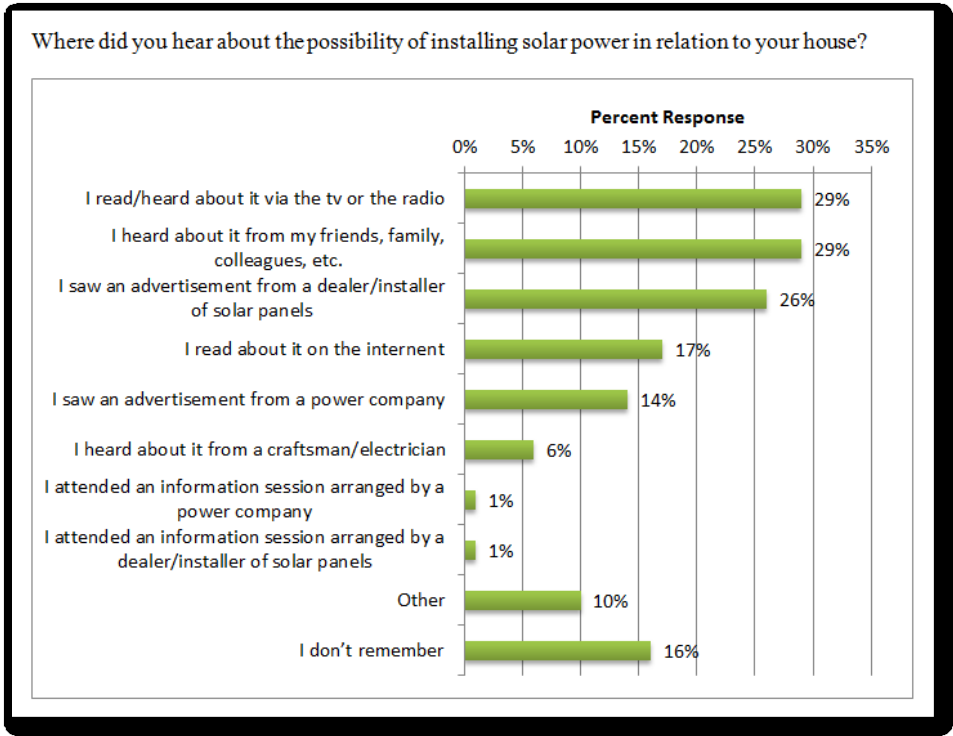


Figure 10: Consumer Responses to “Where did you hear about the possibility of installing solar power in relation to house?”

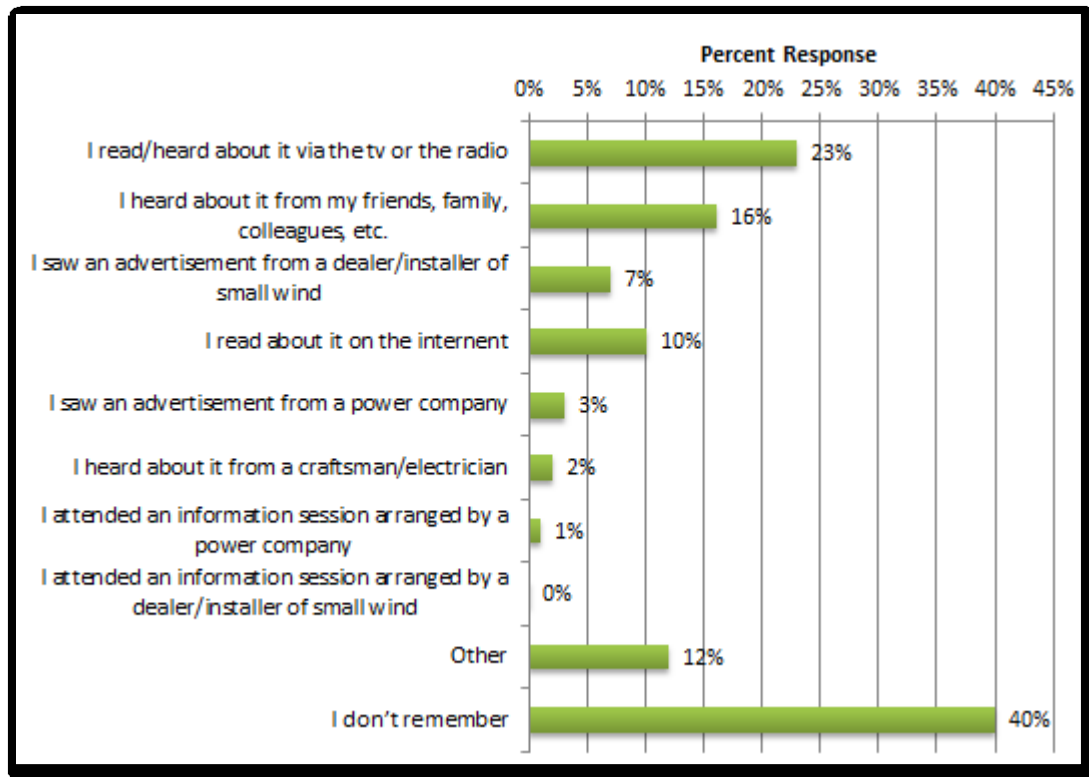


Figure 11: Consumer Responses to “Where did you hear about the possibility of installing a wind turbine in relation to house?”

It is interesting that 14% of our respondents reported hearing about the idea of installing solar panels on their home from a power company. Throughout our interviews with prosumers and industry stakeholders, we found that electricity distributors were not very involved in the home energy generation market; in fact, when we asked prosumers about the role that their electricity provider played throughout the process of purchasing and installing solar panels or a small wind turbine (question 6), they only contacted their electricity provider when there was some kind of problem. All 11 of the prosumers we interviewed said that they hired an equipment installer or an electrician first. It is possible that our survey respondents misinterpreted advertisements from equipment retailers as from their electricity provider, or they could have misremembered exactly where they got the information from; 26% of our respondents said that they heard about the idea of installing solar panels on their home from another source or could not recall.

Consumers would prefer to initially learn about solar and small wind opportunities from brochures, features on the television, and by being individually advised by an expert in the field. These were the top three responses in our survey, selected by 37%, 34%, and 32% respectively by our survey respondents (Figure 12). Interactive information sessions and advertisements in print media also ranked highly.

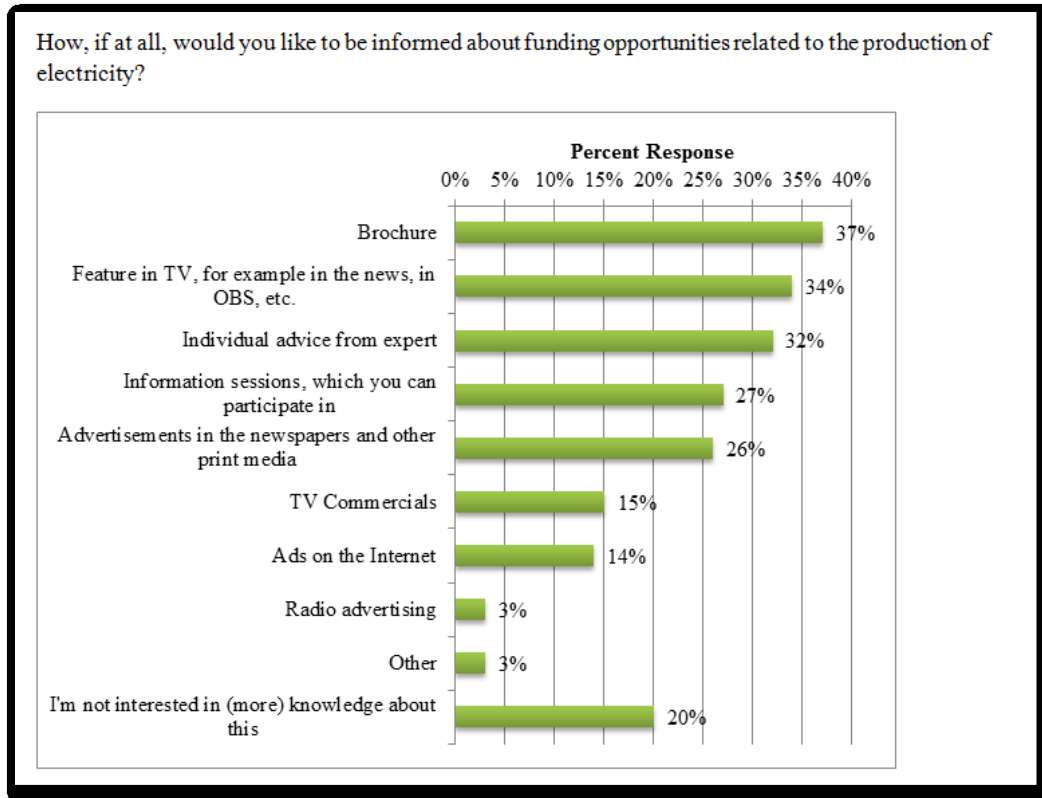


Figure 12: Consumer Responses to “How would you like to be informed about funding opportunities related to the production of electricity?”

This is reflected by the success of a campaign recently commissioned by Energy Service Bornholm. The campaign began with a series of advertisements on television and in local newspapers, and followed up with information sessions held in the homes of consumers who had solar panels. This campaign attracted around 40-50 people at each of 9 information sessions, a total of roughly 350 consumers.

Consumers also found information sessions set up by installers to be useful. We attended two information sessions organized by Stanbaek Anderson, a solar and wind installer, and EnergiMIDT, a solar installer. Each of these sessions accommodated over 100 Danes. The direct interaction provided at information sessions with the installer allows for open conversation regarding home electricity generation. Consumers tended to ask specific questions about equipment and finances at these information sessions and were usually able to get well-informed answers from the presenters.

Despite the relatively high level of interest in information sessions like these, none of the prosumers we interviewed mentioned attending an information session when we asked how they learned about solar panels or small wind (question 3). When asked about what would have streamlined the whole process (question 11), one of the solar prosumers we interviewed specifically mentioned that having some example installations to look at would have helped. This is an interesting disconnect between the resources that consumers want and the resources that prosumers actually took advantage of. This is likely due to our small sample size, however, and an analysis of more prosumers would provide better data.

In contrast, the prosumers we interviewed actually learned of the idea through word of mouth and the internet. Solar prosumers, in particular, usually heard about the idea from a friend who already installed solar panels or planned to do so, and then followed up by researching their options on the internet. One of the solar prosumers we interviewed heard about the idea from a contractor they hired to replace their roof; the contractor mentioned that they could save money on scaffolding if they installed solar panels at the same time.

Prosumers spent a significant amount of time researching equipment, installers, pricing of the systems, and potential benefits of becoming a prosumer. So much so, that one of the prosumers we interviewed commented that “it has to be a hobby.”

Equipment retailers and installers are aware of this trend and take advantage of it. The three installer companies we interviewed, EcoWind, TEKNordisk, and Living Energy, all said that their website was their main advertising source to consumers and that they spent a lot of time and money maintaining it. Living Energy stated that they get 90% of their hits from Google searches. Not only does the internet serve as an effective form of advertisement, but it also allowed customers to gather information instead of spending time on the phone with them.

Although this relationship between consumers and retailers is convenient for each party, it raises some concerns about the nature of the information available to them. There are few sources of unbiased information, and this makes it hard for consumers to shop around. In our interviews with prosumers, we asked about the challenges they faced when learning about generating electricity at home (question 3b). Two of the six prosumers we interviewed expressed difficulty trying to compare the quality of different equipment. “There should be independent information”, one prosumer stated, “there should be some public recommendation.”

In addition, one of the solar prosumers we interviewed mentioned that some information he got from an installer was not entirely correct. The installer they consulted said that inverters would only work with specific multiples of solar panels. When pressed on the issue, the installer mentioned that it was company policy to tell people that in order to make installations easier. When we interviewed equipment retailers, we also learned that at least one withheld pricing information from their website. This was done to keep potential customers interested long enough that they would contact a sales associate.

Consumers also expressed concern in our survey about the information available to them. We asked them whether they thought they had the necessary information to overview the Danish electrical market and select a product or company that is right for them (Figure 13). 70% of our respondents felt that with the information they had, they could not or could only to a lesser extent overview the Danish electrical market, and 68% felt that with the information they had, they could not or could only to a lesser extent select an electrical product or company that would be best for them with the information they had. Given that these results are from a general survey, it's likely that most of our respondents have not looked for this information recently, but it does show a lack of confidence in their ability to make an informed decision.

Do you think you have the necessary information for the following:

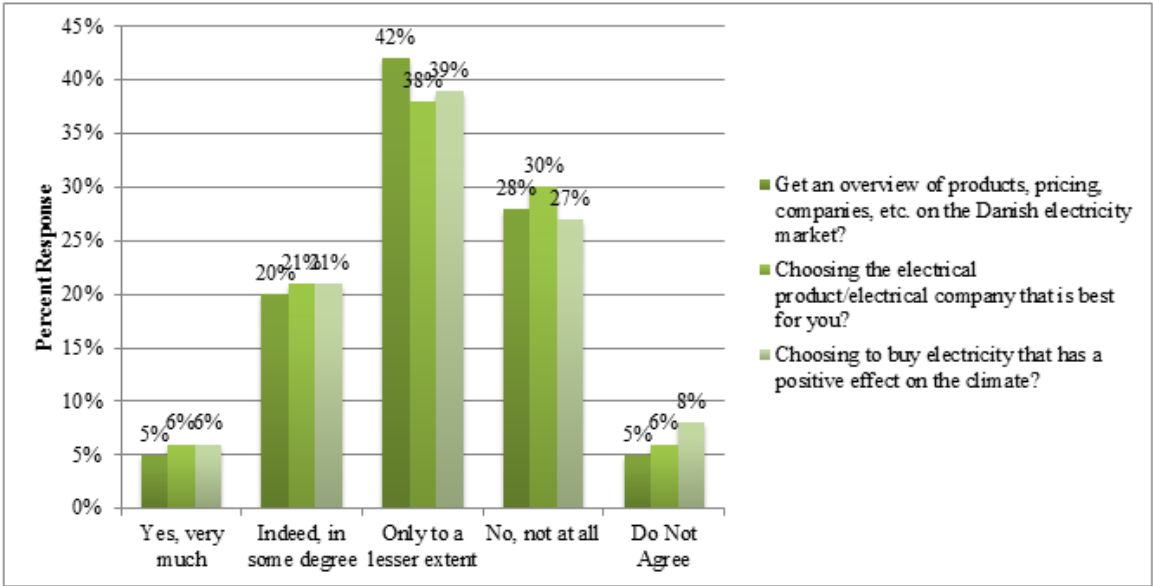


Figure 13: Consumer Survey Responses on Availability of Information for Consumers

What Consumers Know and Don't Know

The general concept of producing energy at one's home and contributing to the grid to save money is well known. In our survey, we asked whether people had considered installing solar panels or a small wind turbine at their home (Figure 14 and Figure 15). Only 4% of our respondents indicated that they had not heard of the opportunity to install a solar panel, and only 11% of our respondents indicated that they had not heard of the opportunity to install a small wind turbine.

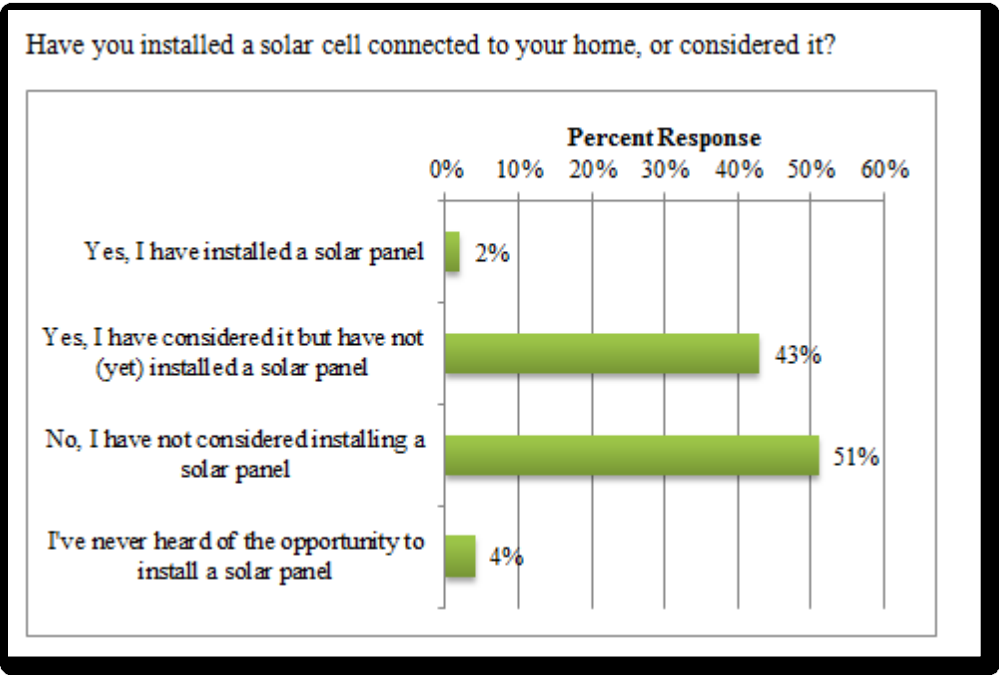


Figure 14: Consumer Responses to “Have you installed a solar cell connected to your home, or considered it?”

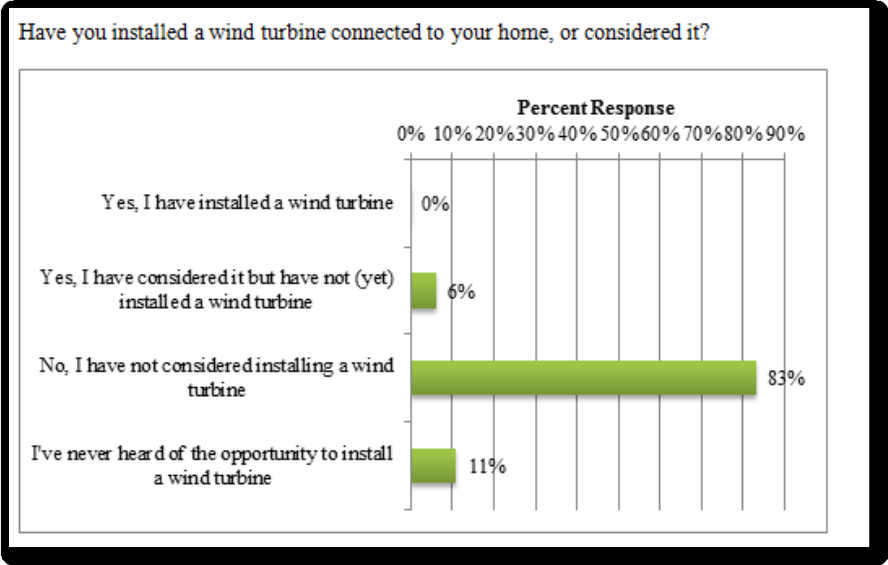


Figure 15: Consumer Responses to “Have you installed a wind turbine connect to your home, or considered it?”

More specific information about photovoltaic solar panels and wind turbines is not as well known by consumers. For both solar panels and small wind, more than 20% of consumers surveyed in the study responded that they did not know enough about the opportunity to install microgeneration equipment (Figure 16 and Figure 17). Some consumers stated that they needed to research options thoroughly before speculating on costs or life span. The majority of consumers know that they can buy equipment to generate electricity, but do not know how the equipment would best work for them.

Although a significant portion of our respondents reported a lack of knowledge about solar panels, many of our respondents that they had considered installing solar panels on their home. This could suggest that consumers have tried to research the idea of installing solar panels, but found it too difficult or confusing to fully consider it. In addition, consumers may have prematurely abandoned the idea as a result of misinterpreting information. More research would be needed to explore these hypotheses.

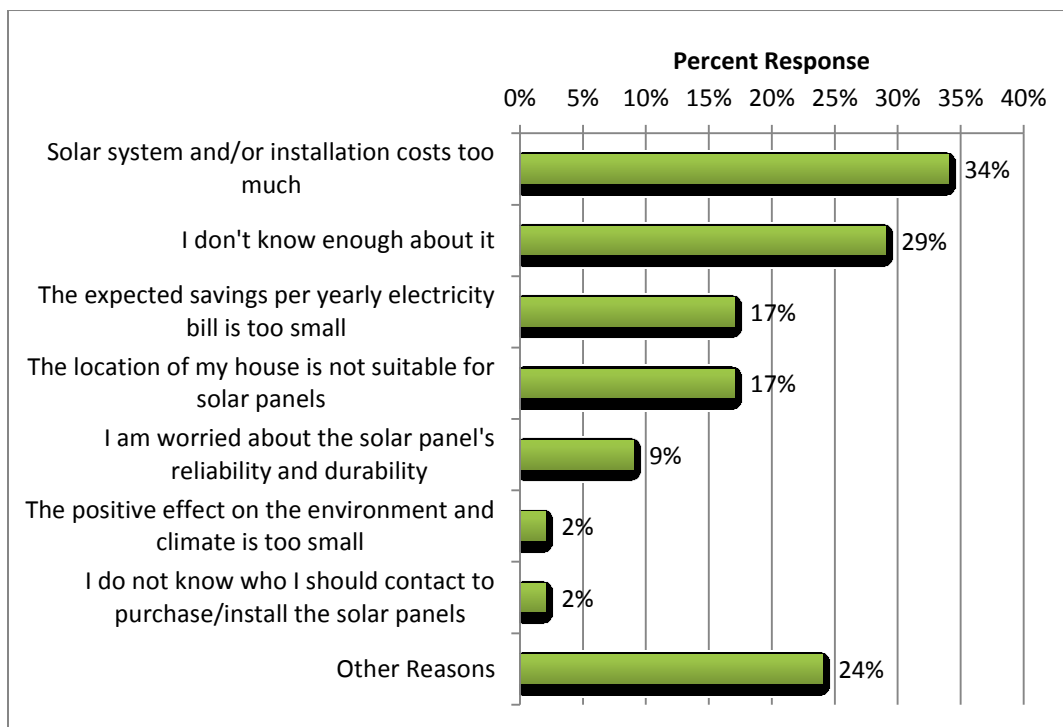


Figure 16: Consumer Responses for "What is the reason why you have not installed solar panels connected to your home or do not even consider it?"

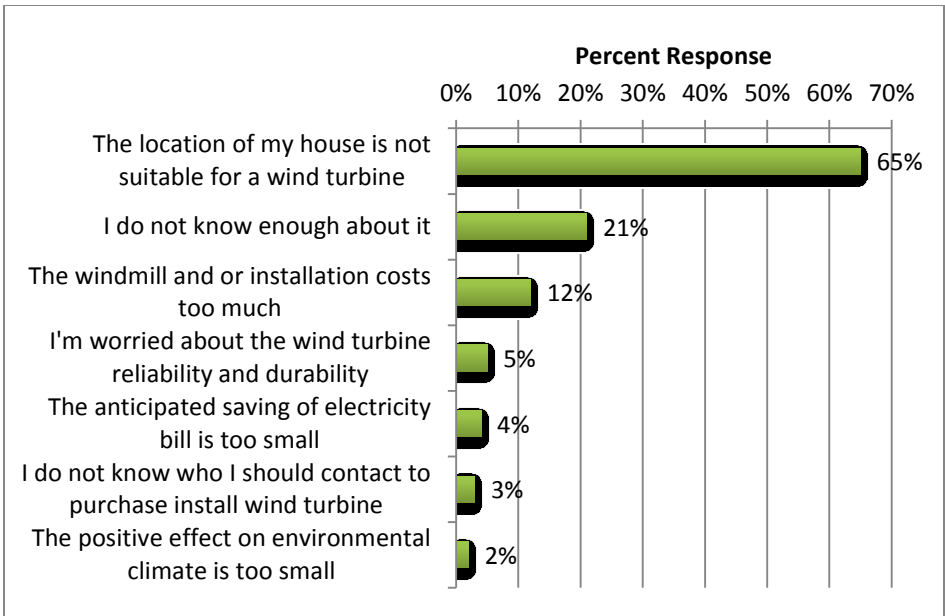


Figure 17: Consumer Responses to "What is the reason you have not installed a wind turbine on your home or have not even considered it?"

There were two areas that people were particularly challenged with: financial information, and equipment specifications.

Knowledge of the government incentive programs for contributing energy to the grid is low among consumers. In our survey, we asked consumers who were aware of solar or small wind electricity generation about the policy of net metering (Figure 18). Only 16% of our respondents were aware of the policy.

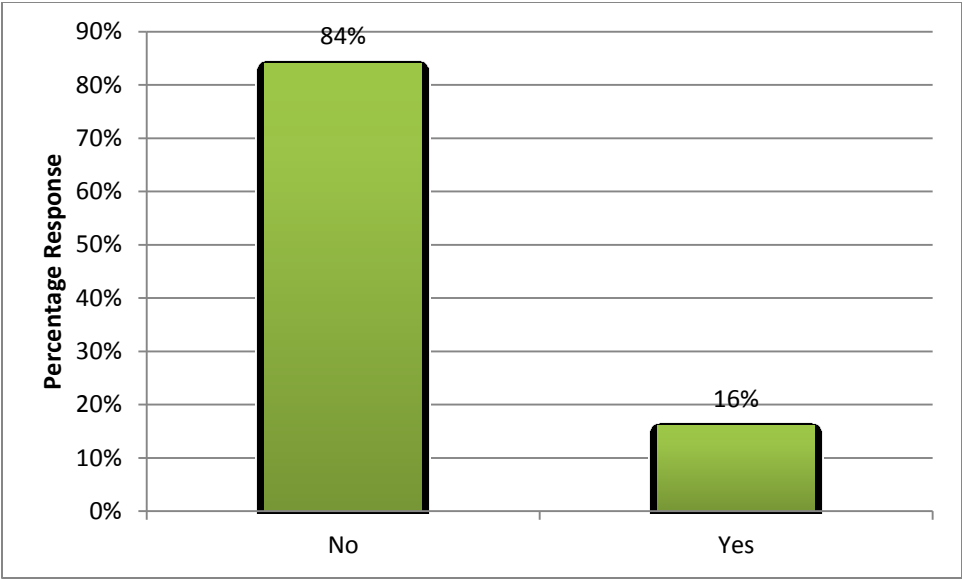


Figure 18: Consumer Responses to “Have you heard of the net meter system?”

Of that 16%, only 68% knew that one’s equipment must be connected to the grid, 46% knew that no transmission charges are paid for the energy you produce yourself, and 38% knew that one cannot produce energy at a rate greater than 6 kW (Figure 19).

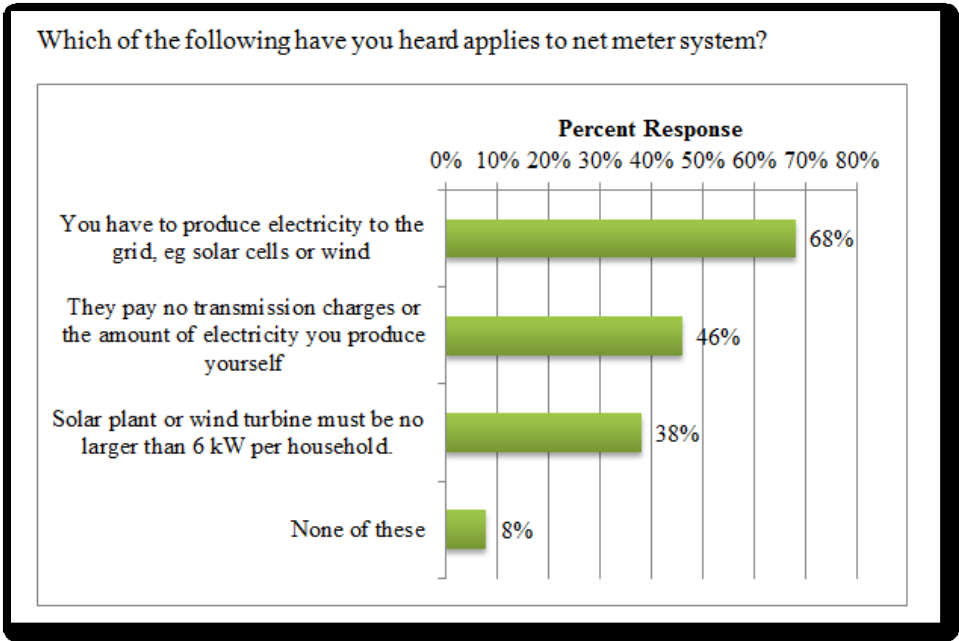


Figure 19: Consumer Responses to “Which of the following have you heard applies to the net meter system?”

We also asked consumers if they knew that one can amortize the cost of solar panels or small wind on their tax return, if they knew that energy companies can give subsidies to consumers for installing solar or small wind, and if they had heard of deducting the costs of labor for installing a solar or small wind turbine system from their taxes. For each of these questions, at least 63% of respondents answered no.

The technical specifications of photovoltaic solar panels and small wind turbines also posed a challenge. In our interviews with prosumers, we asked about the difficulties they faced as they learned about generating electricity at home (question 3b). One prosumer commented that they had to “dig down to read about [home solar generation].” Another mentioned that the information was often very technical. “It’s not easy enough for people who don’t know [about solar panels],” Simon said. “You have to read about different types of equipment.”

One solar prosumer found it difficult to research an appropriate inverter for his home. An inverter is a device that converts the electricity generated by solar panels to a form that can be used by the home and the electrical grid. He spent some time selecting one that had enough 15 amp connections to work with his home’s wiring. Throughout this process, a solar panel retailer told him that an inverter would only work with certain multiples of solar panels, even though this was not the case. He later discovered that it was company policy to recommend these configurations in order to make installations easier. Finally, even the electrician he worked with didn’t fully understand how to connect the panels, and had to come back the next day to wire it correctly.

A common barrier that consumers face when selecting solar panels or a small wind turbine is that there is no rating scheme for assessing equipment quality and reliability. In an interview with Goran, the former head of Go Energi, he emphasized the importance of independent quality labeling. Independent labels make it easy for consumers to analyze and compare product quality, specifications, production and cost. Without this information consumers are left to speculate about the quality of the equipment they were purchasing; for example, many of the people we interviewed were reluctant to buy products made in China and were more confident in equipment manufactured in Europe. Some companies, like TEKNordisk, also expressed a desire for solar panel quality ratings. TEKNordisk only sell panels manufactured in Germany because they feel that the quality of the panels makes their customers more satisfied and guarantees their standing as a reliable installer. These panels tend to be more expensive, however, and this drives customers away who compare products on price alone. TEKNordisk feels that if consumers could more easily determine solar panel quality, then their business would have an advantage in the installer market and thus be more sought after. There is no current rating scheme for small wind turbines either; however, for small wind to be sold in Denmark, the turbines must pass several government quality and testing standards before they are certified for sale.

There are some existing sources of independent information, but they were not utilized by any of the prosumers we interviewed. Energy Service Denmark, a non-government organization, advises consumers on how to save energy and be environmentally friendly in their energy usage. On their website, they advertise information sessions, consultants, and articles about prosumerism (Figure 20). We interviewed their Bornholm island subsidiary, Energy Service Bornholm. They use advertising campaigns through local radio, television, newspaper, consultants and information sessions to reach consumers. Energy Service Bornholm also expressed the need for a better rating scheme for solar panels and wind turbines, such that they can more effectively advise consumers. Energy Service Bornholm will recommend installers for solar panels or small wind turbines for curious consumers, as well provide general information about the opportunities available to consumers. However, this can be difficult as there are very few reports about what is good and what is bad in the home solar and wind market. Some organizations, such as the Center for Renewable Energy in northern Jutland, have made some reports on

small wind turbines, but these resources are not easily accessible to the average consumer and do not cover the entire market.



Figure 20: Energy Service Denmark's Website

Go Energi is a primary source in Denmark for unbiased information about how consumers can save energy and select energy efficient appliances for their home. An organization like Go Energi would be an ideal source of information about solar panels, were the government to fund its creation. However, as a part of the recent DK Energy Agreement of 22/3/12, Go Energi is scheduled for closure in the fall (2012). Some discussions are underway to determine which services will be maintained and which organizations will provide them, but the future of unbiased information in Denmark is unclear and its closure shows a diminishing initiative to provide the necessary information for consumers.

Throughout our interviews, consumers and prosumers stated that research on home electricity generation can be tedious and difficult. They suggested that independent information, provided by an organization not tied to the sale or manufacture of equipment, would have simplified the process for them.

Consumer Motivations

In this section, we will discuss the factors that encourage and discourage consumers from installing photovoltaic solar panels or a small wind turbine.

The most significant motivator for generating electricity at home is economic benefit. In our survey, we asked consumers which of a series of factors would be most important if they were to install solar panels (Figure 21). 30% of our respondents indicated a short payback period was most important, and another 26% indicated that saving money on their monthly electric bill was most important (Figure 22). The third most common factor, indicated by 17% of our respondents as most important, was that the cost of purchasing and installing a photovoltaic solar panel array must be manageable.

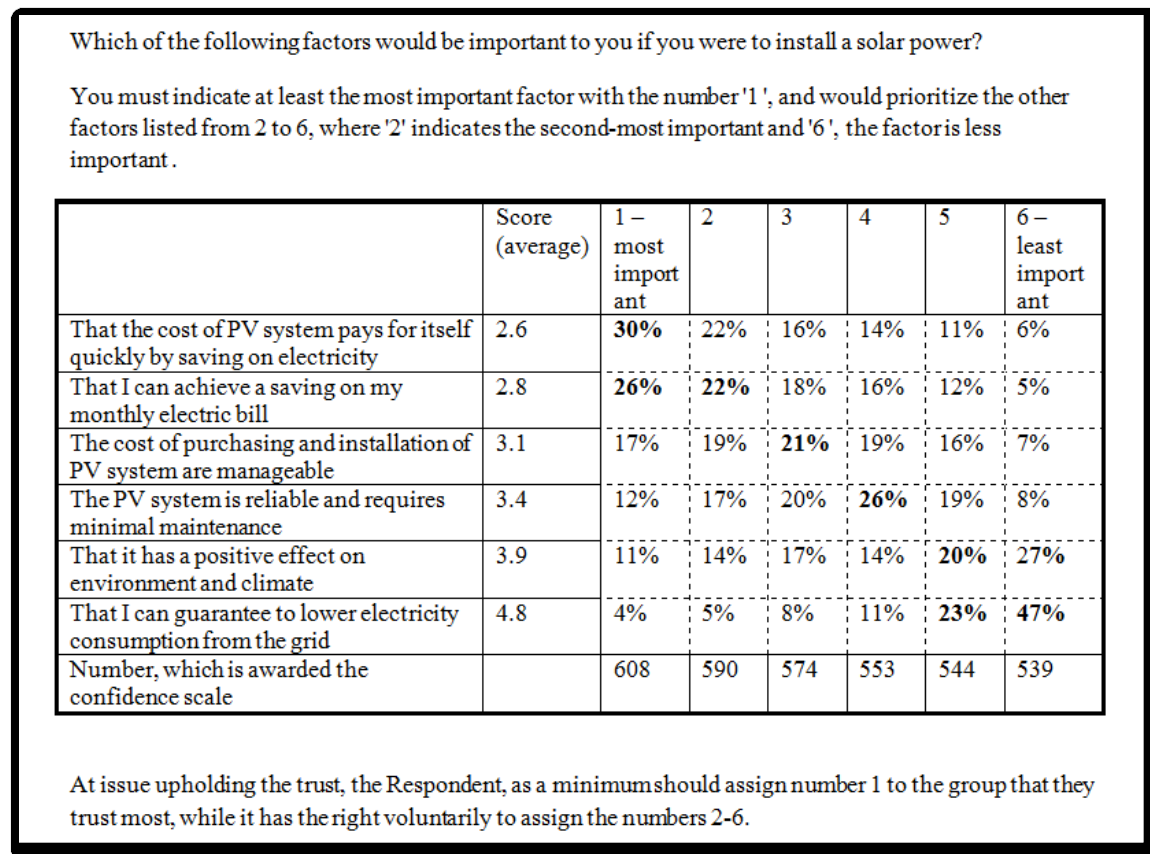


Figure 21: Consumer Responses to “Which of the following factors would be important to you if you were to install solar power?”

This was supported by our interviews with prosumers. We asked prosumers what benefits they expected to receive from the equipment (question 4a) and what made them choose to install the equipment (question 2). Four of the six solar prosumers interviewed said they installed the equipment for financial benefit and one because they had the funds available to do so. Five out of six prosumers expected to benefit financially from their panels. This result continues to support that the economics of a solar panel system is the most important factor to consumers when installing solar power. Throughout the interviews, many of the prosumers provided spread sheets or print outs of costs and payback period of their system, either from their own calculations, internet sources or provided by their installer. Some also expressed

that they view their solar panels as a constant price energy source, securing them financially for the next 20-30 years from Denmark's rising electricity costs. Solar prosumers are very conscientious of their initial investment, but are more focused on their long term electricity costs and return on investment.

Wind consumer responses were similar. A short payback period, savings on the monthly electric bill, and a low initial cost earned 30%, 26%, and 18% of total responses from consumers when asked about the most important factors if one were to install a wind turbine (Figure 22).

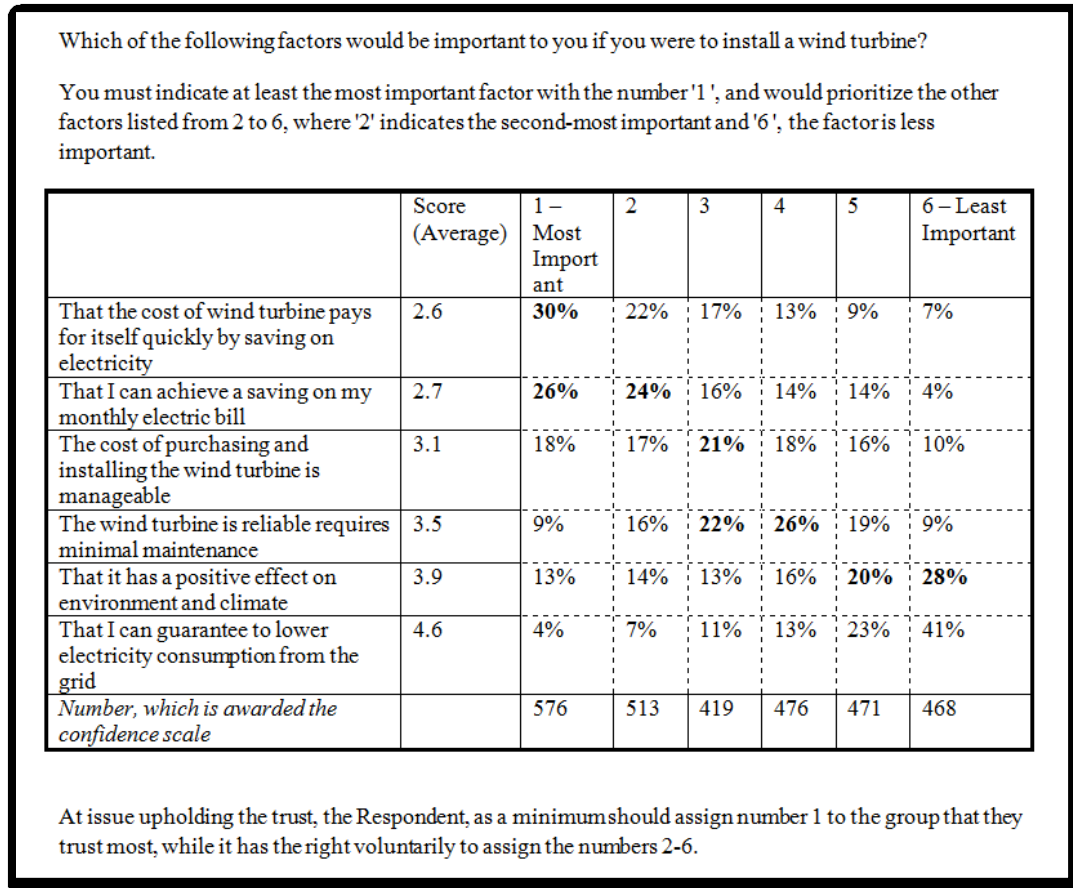


Figure 22: Consumer Responses to “Which of the following factors would be important to you if you were to install a wind turbine?”

Wind prosumers also valued economic factors. When asked about why they installed a turbine (question 2) and about the benefits they expected to receive (question 4), four out of five wind prosumers interviewed mentioned economic benefits as a main motivation for installing small wind, and two out of four prosumers expected to gain economically from their small wind turbine. Some of the prosumers we interviewed, particularly farmers with lots of open area and a large demand for electricity, chose a wind turbine over solar panels. They selected wind turbines because they could scale up and generate electricity at a lower cost than with solar panels.

From this overwhelming evidence, it is clear that saving money is the most important reason why consumers would consider installing solar panels or a small wind turbine. From our interviews with prosumers, we learned that consumers like to conceptualize solar panels or a wind turbine as an energy

savings program under the incentive policy of net metering. Net metering, which we will discuss later in more detail, essentially allows a consumer to cancel out the amount of energy they produce from the amount of energy they consume; they do pay their energy producer for the amount of energy they consume up to the amount that their solar panels or wind turbine produces. Thus, consumers purchase this equipment to fix the price of the energy they use and insulate themselves from the projected rise in energy costs over the next few decades.

Reliability of the technology was an important factor to consumers. This was more commonly mentioned as a concern among consumers surveyed than of prosumers who actually bought the equipment; reliability will be discussed further in the Consumer Reasons for Non-Adoption section.

Some consumers were motivated to install equipment due to the economics of installing in conjunction with other home improvements or installations. One solar prosumer, Simon, installed his solar panels while doing repairs on his roof. The roof installer recommended that they install solar panels at the same time; by installing the new roof and panels together, they saved money on scaffolding. Several prosumers installed this equipment to offset the cost of operating a heat pump. By coupling microgeneration equipment with other home improvements, consumers are reducing the cost of improving their homes.

Another big motivator to install microgeneration equipment is environmental stewardship and concern. In our survey, we asked whether it was important that individuals should make an effort to ensure that energy is produced from renewable sources; 92% of respondents to the survey said they either agreed or strongly agreed (Figure 23).

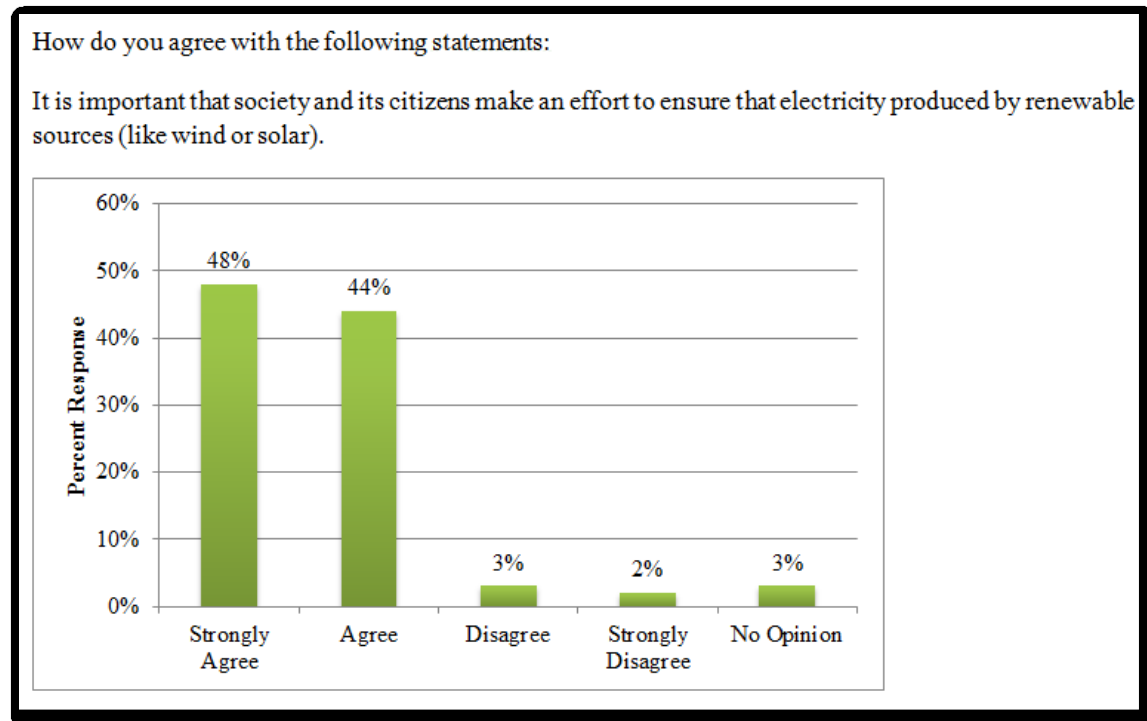


Figure 23: Consumer Responses to “How do you agree with the following statements: It is important that society and its citizens make an effort to ensure that electricity produced by renewable sources (like wind or solar).”

This was supported by our interviews with prosumers. When asked about why they installed solar panels (question 2) and what benefits they expected to receive (question 4a), three out of six solar prosumers mentioned environmental reasons as a motivator, two out of the six felt that it would inspire others to be more conscientious about the environment, and three out of six felt that it was the right thing to do. Simon and his wife Dina, solar prosumers, stated that installing solar panels was “the right thing to do,” and that it was “a good attitude, a good signal to send, and to inspire somebody else [to act similarly].” Another solar prosumer, Peter, cited concerns about reducing the nation’s dependency on oil; “we had to do something”.

Concern for the environment was also mentioned by the wind prosumers we interviewed. When asked about why they installed a turbine (question 2), two of five cited environmental concerns. One prosumer, Stig, mentioned climate change. “We have to do something”, he said.

Some of the prosumers we interviewed, particularly those with an engineering background, thought that it would be a fun project. Two out of six solar prosumers and two out of five wind prosumers mentioned this as a reason why they installed their equipment. Frankie described it as “almost like a scientific experiment in my backyard”. One solar prosumer went even further and designed his own sun-tracking mount for the panels. A few of the engineers we interviewed worked together as a group to investigate installing solar panels.

Consumer Reasons for Non-Adoption

The main deterrent to photovoltaic solar panels was their initial cost. In our survey of consumers, we asked why people have not installed solar panels or why they have not even considered it (Figure 24). 34% of survey respondents felt that solar panels were too costly to purchase and install, and another 17% felt that the savings on electricity would be too small. In addition, we interviewed two consumers who were neighbors of prosumers. Both had considered installing solar panels, but had chosen not to due to their cost. Irma, a consumer, stated that she expected to sell her house within the next two years, and would therefore not see the benefits of the panels. This is not uncommon; some people wrote in similar answers as “other” responses to the aforementioned survey question. Sussane, the other consumer we interviewed, stated that solar panels would be too expensive for her household at the moment. She had recently moved into her current house and was saving her money for general home improvements.

In our background research, we noticed that low-interest loans and other financial programs are offered to buffer the initial cost of solar panels. A similar program is not currently offered in Denmark, and might help address some of the concerns we uncovered.

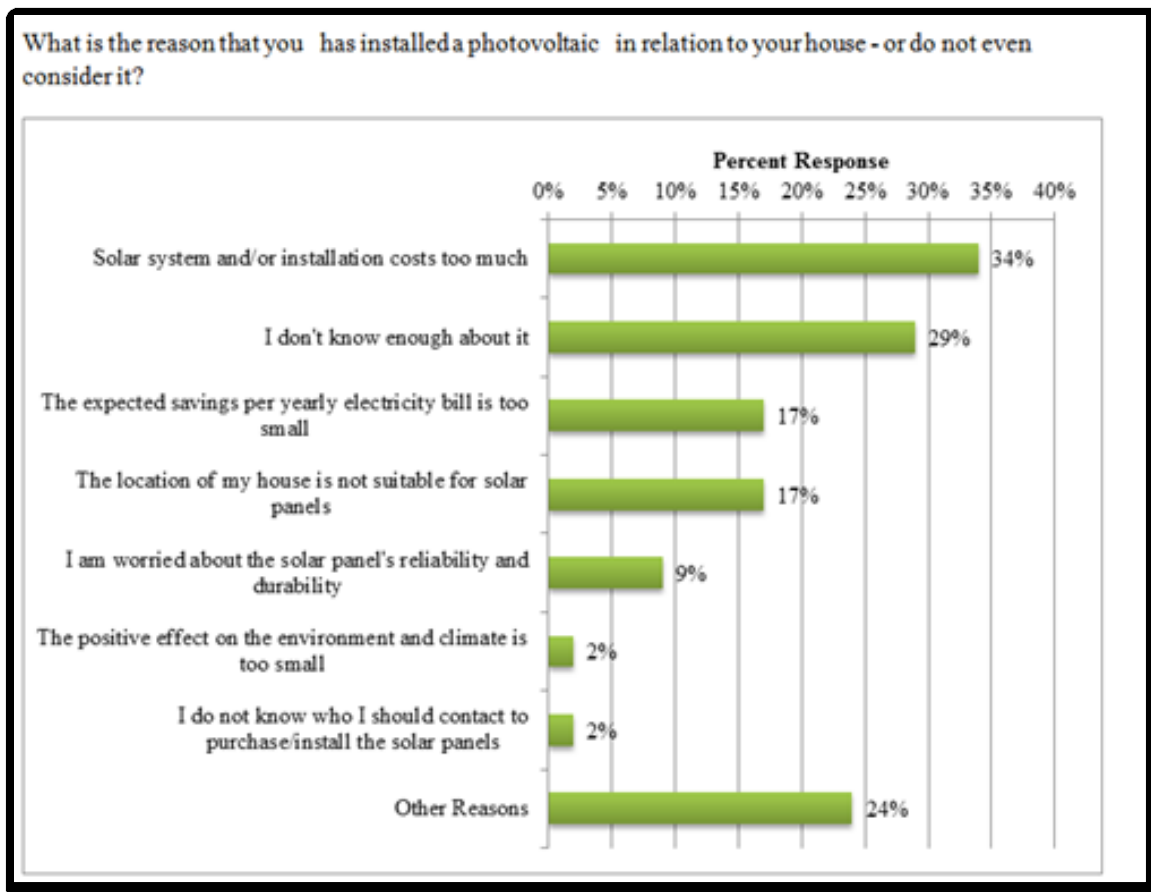


Figure 24: Consumer Responses to “What is the reason that you have not installed a photovoltaic in relation to your house – or do not even consider it?”

Some consumers felt that the electricity savings would not be enough to justify the cost. For households that consume small, usually less than 4 kW on average, the cost of the panels to support their

consumption is too great versus the amount they would save over time. Under the net metering system, consumers get the best deal if they consume a large amount of electricity and purchase microgeneration equipment that will produce an equivalent amount. Small households do not benefit as much as larger consumers, and do not find it as appealing.

Location of the panels can also be a deterrent. When we asked consumers why they have not installed or have not considered installing solar panels (Figure 24), 17% indicated that they felt the location of their home was not suitable. A variety of factors influence this, including the direction that one's roof faces, the strength of the roof, whether there are many windows in the roof, and whether local regulations will permit installing panels on one's home. Each of these factors will influence the finances of the investment as well as how the array of panels looks on one's roof.

For small wind turbines, consumers were most significantly deterred by their location. In our survey, we asked consumers why they have not installed a wind turbine or have not even considered installing a wind turbine (Figure 25). Location was the most significant reason, and was selected by 65% of respondents.

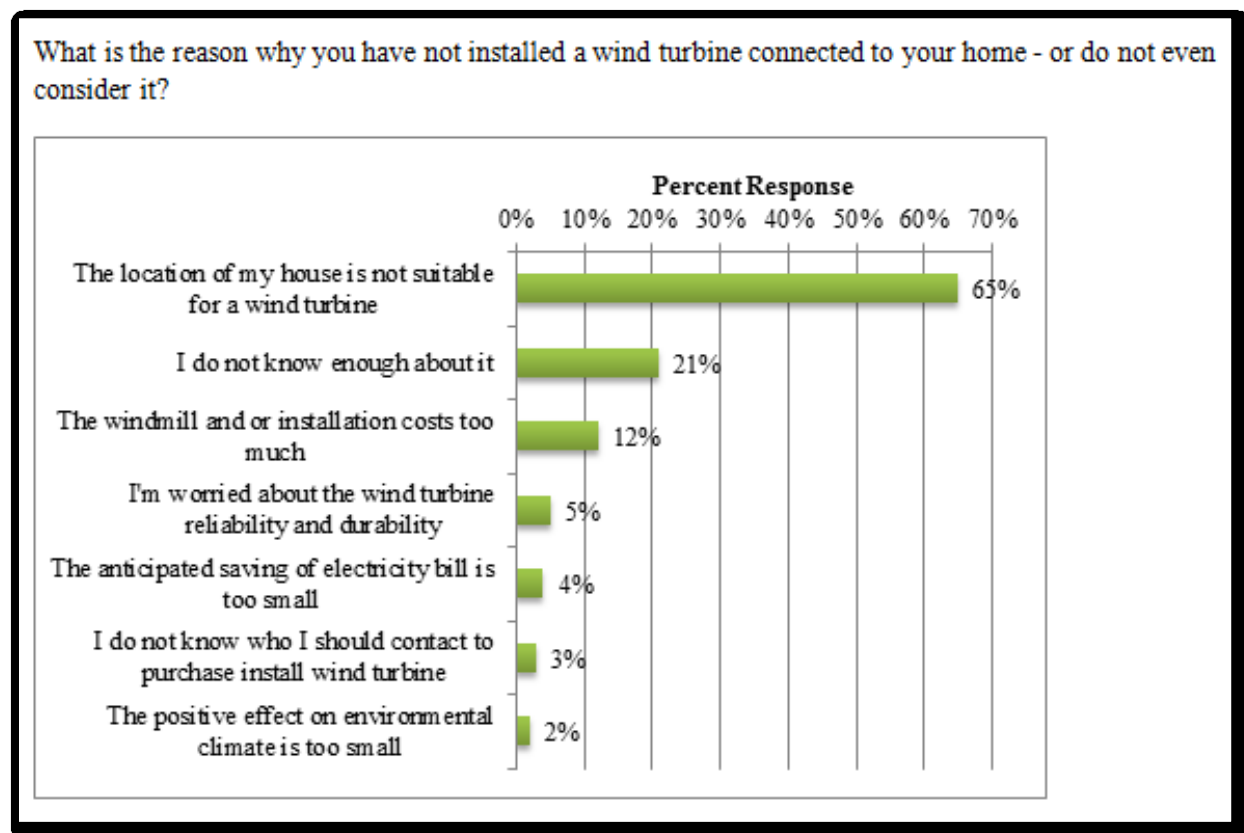


Figure 25: Consumer Responses to “What is the reason why you have not installed a wind turbine connected to your home – or do not even consider it?”

This is understandable; zoning regulations for small wind turbines are much stricter than that of solar panels, and require the local community to approve potential installations. Small wind turbines must be located a distance of at least 4x the proposed turbine's height away from the nearest neighbor to prevent noise and shadowing from adversely affecting others. In addition, the community evaluation process takes a long time, usually requiring between 4 and 6 months to complete. One of the prosumers we interviewed,

Lars, described that he had to contact the Danish Wind Turbine Association to commission an estimate of the shadowing his turbine would cause. He also had to wait for a neighborhood hearing to convene and approve his installation before he could begin installing it. These took 6 months to complete.

Other reasons that consumers reported in the survey were similar to those reported for solar panels; lack of knowledge, the significant upfront cost, and reliability concerns were the next most significant deterrents.

Estimating Costs and Payback Period

Estimating the payback period of photovoltaic solar panels and small wind turbines can be difficult. First, many consumers are not aware of the government incentive programs that would affect the finances of an installation. In our survey, we asked consumers who indicated that knew about of solar or small wind energy generation about their awareness of the net metering program (Figure 26). Out of the group surveyed, only 16% were aware of the net metering program. Of that 16%, only 68% were aware that the equipment must be grid connected, 46% were aware that no transmission fees are paid to one's energy distributor for the energy you produce yourself, and 38% were aware that installations are limited to a capacity of 6 kW per household. The survey also asked consumers whether they were aware that you can amortize the cost of solar panels or small wind on their tax return, whether they were aware that energy companies give subsidies to consumers for installing solar panels or a small wind turbine, and whether they were aware that the cost of labor for installing a solar or small wind turbine could be deducted from their taxes. For each of these facts, a minimum of 63% of respondents indicated that they were not aware of it.

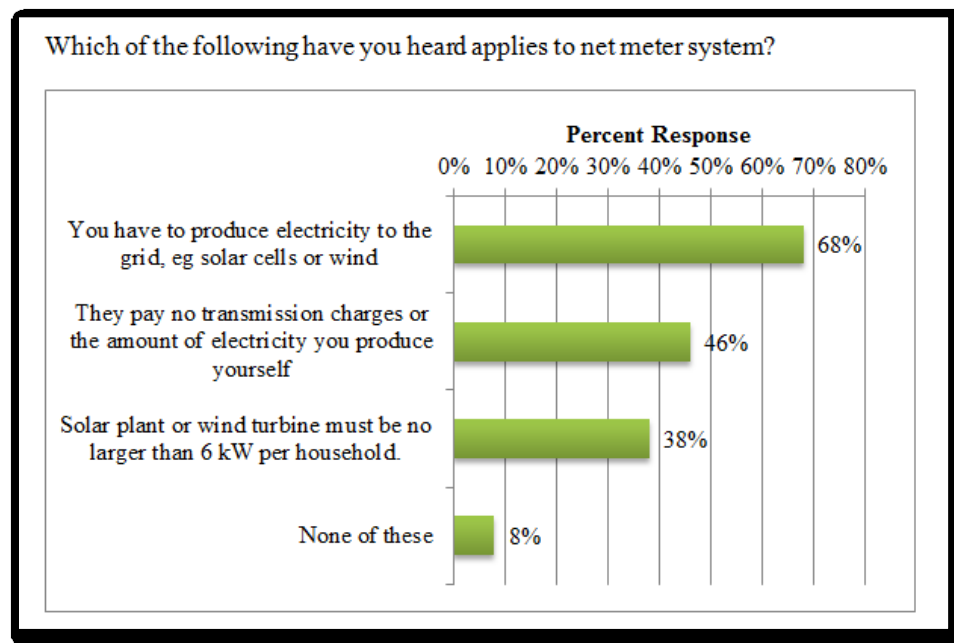


Figure 26: Consumer Responses to “Which of the following have you heard applies to the net meter system?”

Second, even when people are aware of these programs, it can be difficult to estimate the payback period for a particular installation. Five out of eleven prosumers that we interviewed found the government incentive programs to be confusing. One solar installer we interviewed stated that every 2 out of 3 callers interested in buying solar panels asked questions about the tax programs and deductions for prosumers. Energy Service Bornholm, a source of advice about saving energy and using energy in an environmentally friendly way, had to refer consumers with specific questions on the topic to local retailers and installers. In addition, when we attended an information session offered by Stanbaek Anderson, the presenters spent a significant amount of time fielding questions from prosumers. Consumers expressed concern at the session that a major benefit created by the net metering scheme was the fact that they could avoid paying taxes when they consume the amount of energy that their solar

panels or small wind turbine produces. Many asked the representatives from Stanbaek Anderson to estimate how the payback period would change if the tax rate on electricity consumption were adjusted in the future. Many potential customers have to work with an installer one-on-one to make a reasonable estimate of the finances for a particular installation.

The Prosumer Experience

In this section, we will summarize the thought process of prosumers and the actions they took as they selected, installed and used photovoltaic solar panels or a small wind turbine. First, they research their options, as discussed in the section entitled “Learning about Prosumerism”. Second, they select equipment and an installer to meet their needs. Next, they install the equipment. By this stage, consumers often have expectations for how well their system will perform. Finally, they track and assess the performance of their system and maintain it as it ages.



Figure 27: The Prosumer Experience Process

Solar Prosumer Experience

The solar prosumer’s experience differs from the wind prosumers experience in that solar is more versatile than wind. From the results of our interviews with prosumers, we constructed a profile of an average solar prosumer (Figure 28). The majority of solar prosumers owned systems that produced as much energy in a year that they consumed.



Solar Prosumer Profile	
 	
Solar Panel System:	<ul style="list-style-type: none"> • 4kW – 6kW Panel Capacity
Cost of Solar Panel System:	<ul style="list-style-type: none"> • 100,000 DKK (20,000 USD)
Duration of Installation:	<ul style="list-style-type: none"> • 2 Days
Home Electricity Consumption (Yr. Avg.):	<ul style="list-style-type: none"> • 2,000 – 4,000 kWh
Initial Knowledge from:	<ul style="list-style-type: none"> • Word of Mouth • Radio or TV
Research Information from:	<ul style="list-style-type: none"> • Internet • Installation Company
Reason for Installing Solar:	<ul style="list-style-type: none"> • Economic Benefits (Save Money) • Environmental Stewardship
How they Select Equipment	<ul style="list-style-type: none"> • Matched to Balance Energy Usage • Perceived Equipment Quality
How they Select an Installer	<ul style="list-style-type: none"> • Word of Mouth Recommendation • Equipment they Sell • Support Offered
Installation Challenges	<ul style="list-style-type: none"> • Selecting an Inverter • Correctly wiring an Inverter
Actual Performance	<ul style="list-style-type: none"> • Satisfied Overall • Some Inverter Problems

Figure 28: Average Solar Prosumer Profile

Selecting a Solar Installer

Of the six solar prosumers we interviewed, two had their system installed by a certified installation company. They tended to rely upon internet research and word of mouth to select an installer that they felt comfortable with. Confidence that their installer would support the installation if they encountered any problems was an important factor for the prosumers we interviewed.

The other four solar prosumers we interviewed installed their system by themselves with the assistance of a qualified electrician to connect to the electrical grid. As engineers, they wanted to install the solar panels themselves. These four prosumers, therefore, had limited interaction with installers during the process of mounting solar panels at their homes. However, all four talked to a solar panel retailer to help them select a photovoltaic system.

Selecting the Appropriate Solar Panel Equipment

When selecting the optimal system for their homes, all of the solar prosumers that we interviewed were advised by their respective installers or retailers. Consumers had to select solar panels to use and an inverter to go with them. They also had to make sure that their electric meter would work with the system. Overall, prosumers agreed that selecting a system was easy with the guidance of the installer or retailer.

However, prosumers mentioned the following challenges throughout the selection process:

- Aesthetics are challenging
- Selecting an inverter can be difficult
- Solar panel capacity should be matched to consumption

Some consumers find the look of solar panels on their roof unappealing, discouraging them from installing them on their homes. One prosumer we interviewed spent additional time researching their options in order to select a satisfactory arrangement.

In addition, for some communities throughout Denmark, maintaining the original look of older homes is highly valued. In these communities, it may be difficult or impossible to install solar panels on an older home due to local zoning regulations or roof strength. When asked about the challenges they faced throughout the installation process (question 12), one prosumer stated that this mentality of preserving the original looks of homes should be reconsidered if progress is to be made in the market.

The technical details of a solar installation can impede an interested consumer. As discussed in section entitled “Learning about Prosumerism”, prosumers can find parts of the solar panel system difficult to understand. This is reflected in the selection of the appropriate inverter to accompany the panels. One prosumer we interviewed had to select a particular inverter based on the number of 15 amp output circuits and solar panel input circuits he required. For people without a technical background, it may be difficult to fully understand the implications of selecting a particular inverter.

Another aspect of selecting system that consumers have trouble understanding is that solar panel capacity should be matched to household consumption. Under the net metering scheme, electricity consumption is the most important factor in determining the right system to install. Three of the six solar prosumers installed 4kW to 6kW systems. These prosumers aimed to balance their consumption with their production from the panels. Matching consumption with solar panel production capacity optimizes savings, making the system payback period as short as possible. The other three prosumers installed 1kW to 1.5kW systems. Unlike the other prosumers, their main reason for installing these smaller systems was to have fun producing their own electricity.

What concerned the prosumers intending to match solar panel production with their consumption is selecting the right panel capacity to optimize savings and the payback period. Simon and Dina selected a 4kW solar panel system after carefully analyzing their average yearly electricity consumption with their installer. Based on the numbers they estimated, the 4kW system would provide the best return on the investment.

Solar Panel Equipment Installation

Selecting the equipment posed the most troubles for the solar prosumers we interviewed. However, once the equipment was selected and ready to be installed it took an average of 2 days to install everything. The four prosumers that installed their own equipment stated that their installations did not exceed more than one day to install everything. Even with the relative ease of installation, some prosumers acknowledged several challenges that they had to overcome during the 2-day process.

These challenges included:

- Placing panels for optimal production
- Understanding the technical details of inverters
- Upgrading the electricity meter

To get the maximum production from solar panels in Denmark, it is recommended that the panels be mounted at a 40-degree incline from horizontal on a surface facing south. Two prosumers we interviewed said they had an almost optimal roof incline and direction to install solar panels. For surfaces not facing directly south or precisely at a 40-degree incline, it may still be reasonable to install solar panels, although their production will not be optimal. Valter indicated that a nearby neighbor, interested in installing solar panels after seeing Valter's system, found that their roof was not optimal for installing panels. In the case of Valter's neighbor, an installation could still be possible; however, the upfront cost would be higher because more panels would need to be installed.

Understanding the inverter can also hinder the entire installation process. The inverter is a critical part of a home electricity generation system.

The prosumers we interviewed had the most difficulty with:

- The technical aspect of the inverter
- Installation of the inverter when connecting to the grid

The inverter is the most technical aspect of a solar panel system. One of the two solar prosumers without an engineering background acknowledged that the technical aspect of the inverter was confusing. It was a challenge to comprehend how the inverter would be connected to the grid and the solar panels. The type of inverter needed for their system was also difficult to understand.

Two of the prosumers we interviewed had some trouble connecting their inverter to the electrical grid. Peter, owner of a 6kW solar panel system, found it difficult to synchronize his Austrian inverter with the grid connection. The electrician that installed the inverter had troubles when matching the frequency of the inverter output with the frequency of the electricity on the grid, preventing it from producing energy. For Valter, his electrician originally connected the solar panels to the inverter incorrectly, but the problem was quickly resolved after another day of work. After installation, Valter had another problem with the inverter performance. On a normal day, both Valter and his prosumer neighbor noticed that their inverters shut off. There is still no explanation for the phenomenon; however there have been no other shut offs from the inverter. Their retailer was not able to diagnose the problem.

Another potential difficulty when installing solar panels can be replacing the electricity meter. This replacement may also include an extra cost that some consumers may not be aware of until exchanging the meter. Depending upon the energy distributor, prosumers may be required to upgrade their electric meter to a model that can measure production separately from consumption. Prosumers might also wish to install a new meter in order to monitor their energy usage more conveniently. Valter was unable to upgrade his meter after contacting his utility company. He was looking to upgrade to a new digital meter in order to monitor his energy usage more easily, but his energy distributor would not provide one because the upgrade was not necessary for his solar panel system to operate.

Despite the occasional setback installing an inverter and the time spent researching equipment options, all of the prosumers we interviewed indicated that the overall process of purchasing and installing solar panels was easy. The prosumers we interviewed either hired an installer, or installed the panels themselves and hired an electrician to wire them to the grid. Installers handle the entire process of mounting the panels on their roof and bringing in a certified electrician to wire them together. In addition, many installers provide a guarantee on the quality of their installation work. Those who chose to install the panels themselves did not find the process any more difficult, but they did tend to describe themselves as handymen.

While there was a hands-on aspect for the prosumers that mounted the panels themselves, none of the prosumers we interviewed consulted their electricity provider directly throughout the installation process. The installer or the electrician they hired handled all of the necessary arrangements. One of the prosumers we interviewed contacted their energy provider after the installation to check that their records correctly indicated that he had installed solar panels. He noted that their energy provider did not provide any indication that he had installed solar panels, and wanted to make sure that his energy production was being recorded appropriately.

Actual Performance and Maintenance

In this section, we discuss the lasting impressions prosumers had of their solar panel installations and information relevant to maintenance of their panels. We found:

- Inverters last 15 years and panels last 45
- Prosumers are more aware of their energy usage, but do not always change their habits
- Systems live up to expectations
- All interview participants recommended that others install similar equipment

An important fact that many consumers are unaware of is the lifespan of the inverter. In our interview with Living Energy, we learned that inverters will last about 15 years. While the typical solar panels produced today are made to last at least 30 years (up to 45 years), the inverter is only expected to last approximately half that time. With a 15-year lifetime, the inverter requires replacement at least once, if not more, throughout the entire solar panel system's operation. Many consumers lack the knowledge to realize the need for replacing the inverter; however, installers and retailers can provide the necessary guidance to keep them aware of additional costs (i.e. inverter replacement) later on in the systems' operation. Some prosumers mentioned that the lifetime of inverters could be reduced slightly if they are mounted in a location where they are not adequately cooled. Replacing the inverter however, was not a major concern for prosumers when installing their system.

A surprising response we uncovered was when we asked if prosumers changed their energy usage habits now that they have solar panels (question 9). Four of our six prosumers mentioned that they are more aware of their usage, but three of the six said they had not changed their usage behavior. On the other hand, three of the six reduced their usage. The prosumers that did not change their energy habits were advised to consume the amount of energy they produce. Under the net metering model, prosumers get the shortest payback period if they follow this energy usage model. This will be discussed in more detail in the section entitled "Incentive Program Details".

Based on prosumers' consumption, savings, and average production since installation, we asked whether their equipment has met their expectations (question 8). Two of the six prosumers we interviewed reported that they were fully satisfied with the amount of energy they were producing. Two other prosumers mentioned they had trouble with their inverter, but were otherwise satisfied with the installation. Peter, another prosumer, mentioned that he did not have any expectations for their energy production beforehand, and installed solar panels with an open perspective on how well they would produce. Still, Peter agreed that he was satisfied with his choice to purchase the system. The sixth prosumer we interviewed had not completed the installation, and thus could not answer this question. Overall, prosumers were satisfied by their choice to install solar panels, despite some troubles afterwards.

We also asked prosumers whether they would do anything differently if they were to purchase similar equipment given the knowledge they now have (question 12). Three of the six prosumers we interviewed said that they would do nothing differently. The remaining three suggested separate changes to their product selection process. Simon and Dina said that they would have done more research on panel quality and would have taken a closer look at other installation option. Frankie would have bought panels in Germany to save money and Ronny would have bought a larger inverter when making his purchase in order to make it easier to add more capacity later.

Despite these minor problems, all six prosumers were enthusiastic about their choice to install solar panels. In our interviews, we asked whether they would recommend that others install similar equipment (question 10). All of the prosumers recommended that others install similar equipment. Three of the six cited the economic benefits as a reason to purchase and install solar panels, two out of the six cited the environmental benefits, and one of the six thought the experience was fun.

Wind Prosumer Experience

Consumers have fewer small wind turbine options than they have for solar panels. Based on the information we collected from interviewing prosumers, we constructed a profile of an average wind prosumer (Figure 29). The majority of wind prosumers are farmers and own large areas of land, allowing for an installation of a wind turbine. The outlets for knowledge and research were very similar; however, between solar and wind prosumers.

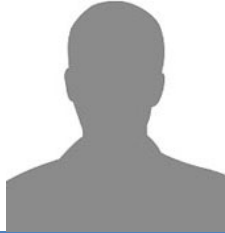

Wind Prosumer Profile	
	
Wind Turbine System:	<ul style="list-style-type: none"> • 6kW – 11kW Wind Turbine Capacity
Cost of Wind Turbine:	<ul style="list-style-type: none"> • 300,000 DKK (60,000 USD)
Duration of Installation:	<ul style="list-style-type: none"> • 1 Day
Home Electricity Consumption (Yearly Avg.):	<ul style="list-style-type: none"> • 6,000 – 15,000 kWh
Initial Knowledge from:	<ul style="list-style-type: none"> • Word of Mouth • Radio or TV
Research Information from:	<ul style="list-style-type: none"> • Internet • Installation Company
Reasons for Installing Wind Turbine:	<ul style="list-style-type: none"> • Economic Benefits (Save Money) • Environmental Stewardship
How they Select Equipment	<ul style="list-style-type: none"> • Matched to Balance Energy Usage • Perceived Equipment Quality
How they Select an Installer	<ul style="list-style-type: none"> • Word of Mouth Recommendation • Equipment they Sell • Support Offered
Installation Challenges	<ul style="list-style-type: none"> • 4-6 Month Approval Process
Actual Performance	<ul style="list-style-type: none"> • Satisfied Overall • Unexpected Turbulence can Reduce Production

Figure 29: Average Wind Prosumer Profile

Selecting the Small Wind Turbine Installer

Of the six wind prosumers we interviewed, three chose their installer after being referred by word of mouth. One prosumer, Hugo, discussed wanting to install a small wind turbine with a neighbor at a Christmas party who put him into contact with a Gaia-Wind representative. He later chose Gaia-Wind based on his neighbor's recommendation. Hans, another prosumer, chose the installer of his wind turbine from recommendations by other small wind turbine owners. A third prosumer, Stig, chose his installer because he had heard good recommendations about the company and he liked the design of the turbines they sold.

These three prosumers chose to hire a company to complete their wind turbine installation, while the other two self-installed their systems. However, these two prosumer still required their installer for supplying the turbine and to provide the electrician to connect the system to the grid. By Danish law, a certified electrician is required to connect any energy generating system and inverter to the electrical grid. The two prosumers who self-installed their systems laid the basic foundation for their equipment and the cables to connect the wind turbine to the meter. Stig and his neighbors installed his wind turbine, shown below in Figure 30.



Figure 30: A Wind Prosumer and Friends Self-Installing his Small Wind Turbine

Selecting the Appropriate Wind Turbine Equipment

When selecting the optimal system for their homes, all of the wind prosumers that we interviewed were advised by their respective installers or retailers. The systems they chose were accompanied by an inverter, which the installer recommended to optimize the small wind system. In order to complete the system the meter was also assessed for adaptability with the wind turbine and inverter. Overall our prosumers agreed that selecting a system was made very easy with the guidance of the installer or retailer. However, the following challenges were uncovered by prosumers throughout the selection process:

- Equipment had to meet local zoning regulations and neighbor approval
- Equipment and electrician certifications are complicated
- Selecting an inverter and meter can be difficult

In order to install a small wind turbine, consumers must get zoning approval and neighbor approval of their installation. The zoning board of the particular installer's area must determine whether the wind turbine is too close to neighbors or other buildings, and certify that the location of the wind turbine is within regulations. The process also includes a neighbor approval process, in which all surrounding neighbors are asked to fill out a form either approving or disapproving of their neighbor's installation. This process can take between 4-6 months to complete.

These certifications reach further than just local zoning regulations as well. Small wind turbines that are sold in Denmark must be approved and certified by the Danish Energy Agency for sale in Denmark. This process is very expensive for manufacturers of small wind turbines to complete, and therefore there are few who are willing to pay the price. Most manufacturers who do choose to have their turbines certified must sell over 100 turbines to pay off the certification costs and begin making a profit. Electricians are

also required to have a certification for wiring small wind turbines into the grid. This certification is very costly for the electrician, and can make their services expensive for people installing small wind turbines.

As discussed in the section entitled “Learning about Prosumerism”, prosumers can find parts of the wind turbine installation difficult to understand. In particular, this is reflected in the selection of an appropriate inverter.

Along with problems with the inverter, electrical meters can also be a problem. Stig, a wind prosumer, mentioned problems when trying to get the appropriate meter to account for the new wind turbine. At the time, the utility provider was short on smart meters to give to their customers. Stig had to wait two weeks before receiving and installing the meter. While these problems are sometimes unavoidable, these cases suggest that utility providers are somewhat unprepared for the recent surge in home generation equipment installations.

Wind Turbine Equipment Installation

Wind prosumers generally felt that the installation was easy to complete (interview question 5e). When asked about the installation process (interview question 4b), they responded that installation process usually started four to two months in advance before the physical installation occurred, and that physical installation took place in only one to two days. Most prosumers said that nothing could have been changed about the process to streamline the process (interview question 11); however, two prosumers said that they were unaware about needing to inform EnergiNet.dk of their equipment, and that they would have like the approval process to be shorter. The only aspects about the process of which prosumers wish they could change (interview question 12) would be that a vertical axis wind turbine be available for purchase and that they could increase the size of their turbine.

Actual Performance and Maintenance

The wind prosumers we interviewed stated that they have had their equipment from a range of thirty-one years to six months (question 7). All of the prosumers interviewed had little to no problem with the maintenance of their turbine. When asked if the equipment had met or not met their expectations (question 8), most wind prosumers were satisfied, except for one who experienced turbulence near his turbine, resulting in unexpectedly low energy production. Two out of four wind prosumers interviewed changed their energy usage after purchasing their equipment (question 9).

Incentive Program Details

The prior sections have focused on consumer experiences and attitudes towards the small wind turbine market. In this section, we will summarize the specific details of the government incentive programs for generating electricity in Denmark, and some key points from recent discussions about how the incentive programs could be improved.

There are two tax schemes available for solar and small wind energy generation in Denmark: the net metering scheme and the business scheme. When a prosumer applies for tax deductions associated with the two schemes, they must choose between the two packages and are bound to whichever package they choose the first time they apply. Net metering stipulates that the annual energy production of a household will offset an equivalent amount of energy consumption for the household. For example, if a household consumes 4000 kWh/year, and produces 3000 kWh / year, the household would only have to pay for 1000 kWh of electricity for that year. If a household produces more energy than it consumes, the household is credited for it at the rate of 0.60 DKK / kWh. After the first 10 years, extra energy is credited at the rate of 0.40 DKK / kWh. This credit is derived from the tax on electricity consumption, which the prosumer is exempt from for the energy they use that is matched by the energy they produce. Net metering energy usage is settled on annually. Under this scheme, 60% of the total income from the production of electricity back to the grid minus a deduction of 3,000 DKK must be included in the owner's personal taxable income (Gaia Wind, 2012). No deductions are provided for the running costs of the equipment or the equipment's depreciation.

The business scheme is instead calculated by the amount of income generated by the solar panels or wind turbine. This income includes a settlement with Energinet.dk for the sale of electricity production, waived taxes on electricity that the prosumer consumes from their wind turbine, and tax deductions for operating expenses, repair, insurance, meter rental and depreciation of the wind turbine (a maximum of 25% each year for the first 4 years). The business scheme has been acclaimed to have a quicker return on investment than the net metering scheme due to the yearly tax deductions within the first 4 years of ownership. Small wind turbines and solar panels are also bound by a maximum capacity 6 kW. There is one exception to this rule; if groups private residences occupy the same plot, like an apartment complex, the households can pool their allotted capacity together and purchase a larger system of 6kW per 100 square meter of floor space, but each residence still is required a to have their own individual meter with a maximum production capacity of 6 kW connected to it.

Several non-government organizations (NGOs) and one electricity distributor expressed concerns about the net metering program. The Ecological Council, an NGO which promotes sustainable development in Denmark, is lobbying to change the energy production incentive programs (Dyck-Madsen, S., Bøndergaard, M. 2012). They identified five major concerns with the current net metering scheme (Figure 31):

- | |
|--|
| <ol style="list-style-type: none">1. The net metering system may in practice not be fully used by multi-story buildings2. The net metering system restricts the amount of solar that can be installed per household inappropriately3. Solar cell owners do not pay for their use of the grid4. The existing subsidy (tax break) of 60 ore/40 ore is too low5. The net metering facility shall be brought in line with the Smart Grid |
|--|

Figure 31: Problems Identified with the Current Net Metering Scheme by the Ecological Council

Under the net metering scheme, system installations are restricted to a maximum capacity of 6 kW. In addition, the energy produced by a system must be directly compared against the amount of energy produced by the owner of the system. This has troublesome implications for a complex containing multiple tenants; in order to leverage the net metering scheme, each tenant must have their own meter and their own set of wiring to use it. This is even more complicated for rental housing; in this scenario, all tenants must agree to install solar panels on the roof and to surrender their right to free choice of an electricity provider in order to enter a net metering agreement with a particular electricity provider. This vote must be unanimous.

Due to the limitation of 6 kW per household and that consumers benefit the most when they consume as much energy as they produce, consumers are not incentivized to fully harness the solar energy available to them. In addition, the grid assumes the role of a battery under the net metering scheme, accepting and providing energy as needed, but a prosumer does not pay for this service. Dong Energy, a government-regulated energy distributor that serves most small electricity consumers, discussed the effects of prosumer electricity generation on the electrical grid with us. They are currently studying the impact of prosumerism on the grid infrastructure and suspect that renovations will be necessary to accommodate it, but are unsure of how the renovations will be paid for.

Finally, the net metering system does not appropriately reflect the market value of electricity at the time of its production and consumption to the consumer. Consumers may contribute energy when it is abundant and cheaply available, and then draw an equivalent amount of energy later when it is more scarce and expensive without any reflection of this disparity on their bill.

- | |
|---|
| <ol style="list-style-type: none">1. Supplement with the possibility of feed-in tariff for residential buildings2. Expansion of the capacity limit from 6kW to 12 kW per dwelling – and increase of feed-in tariff for excess production3. Introduction of the disposal fee for use of the grid as storage4. Increase of the current feed-in tariff for installations outside the net meter system5. Net metering scheme can be used as hourly billing6. Taxation using the feed-in tariff7. The magnitude of the feed-in tariff for various technologies |
|---|

Figure 32: Proposed Improvements to the Net Metering System

Due to these and other concerns, the Ecological Council has proposed a series of reforms (Figure 32). Most notably, the Ecological Council prefers the concept of a fixed-rate feed-in tariff over net metering. This would resolve many problems with the net metering model. First, housing collectives would have a much lower barrier to entry, because they would not be required to install separate electric meters for

every tenant. Second, a feed-in tariff would promote larger equipment installations, because the economic value of a system is directly tied to the amount of energy it produces instead of being tied to the difference between one's consumption and one's production. Finally, people would not be incentivized to maintain their current amount of usage, because the value of a system is created by how much the system produces instead of how much energy consumption a consumer can cancel out. In addition, the Ecological Council also recommends that the distribution fee included in one's energy bill be raised across the board in order to pay for the grid reinforcement required by prosumerism. For more detailed information about their proposed changes, see the Ecological Council's report (Dyck-Madsen, S., Bøndergaard, M. 2012).

Conclusions and Recommendations

One goal of this project was to learn about the market for solar panels and small wind turbines from a consumer perspective. We investigated the attitudes that consumers and prosumers had toward the technology, what would and did motivate them to investigate it, the technical details of the equipment required and the finances involved, and the experiences prosumers had selecting, installing, and using their equipment.

Consumers first learn about prosumerism from broadcast media and people they know, and they would like to learn from brochures, features on television, and one-on-one consultations with experts. Consumers also liked the idea of interactive information sessions and consistently attend them when they are offered.

Prosumers, on the other hand, actually learned by word of mouth and by researching on the internet. They spent a lot of time consulting websites for information, and consistently learned from the websites of photovoltaic solar panel and small wind turbine retailers and installers. We noticed a conflict of interest between prosumers and equipment retailers, wherein retailers want to convince people to buy from them, but potential customers want a complete and correct understanding of the market. In addition, understanding the tax and incentive policies and other factors that go into the initial investment and payback period of microgeneration equipment is a daunting and stressful process. Consumers are often confused by the different tax and incentive programs and require significant help when addressing them. Prosumers would have liked to have had a source of unbiased information.

We also learned that many consumers are familiar with the concept of contributing electricity to the grid in order to save money on their electric bill. However, they know little else about their options in the marketplace and the incentive programs that are available to them.

Prosumers reported similarly; some had trouble understanding the technical details of the equipment involved, which made selecting and wiring an inverter correctly a challenge. Prosumers did not have a lot of information comparing equipment cost or quality and expressed difficulty attempting to select equipment; prosumers and retailers alike would appreciate an independently managed equipment quality rating scheme.

We learned that consumers were most significantly motivated by quick return on investment and low initial costs. Solar prosumers were also motivated by environmental concerns. Some consumers were motivated to install microgeneration equipment with the installation of other renewable energy equipment, such as heat pumps. Consumers were most discouraged by high costs and some believed that the savings were not enough to justify the costs. Most consumers also believed that they could not install equipment on/near their homes, particularly small wind turbines, due to local regulations or home structure. Consumers were also concerned with solar panel reliability.

We also learned about the experience of installing and using equipment. Choosing an installer and installing the equipment for solar panels or a small wind turbine is a very personalized process. Consumers usually choose their installer via word of mouth or by what equipment they supply. Consumers then choose to have their installing company install the panels for them. Although some of

our interviewees installed the panels on their roof themselves, they may not be typical, and doing so has its challenges. The main conflicts prosumers face when going through this process is completing the zoning and neighbor approval processes for small wind turbines. Most solar panels have a very short installation time, lasting at most a week or so, while small wind can take from 8 weeks to a couple months. Consumers on average are satisfied with their equipment in the long term; however, most of those we interviewed recently installed their equipment and have yet to experience the long term aspects.

Photovoltaic Solar Panels vs. Small Wind Turbines

Throughout our research, the contrast between solar panels and small wind turbines became apparent.

Interest for photovoltaic solar panels is growing steadily. Many of the consumers we surveyed indicated a familiarity with the idea of installing them, and a large portion of those people had actually considered installing solar panels on their home. Although many consumers were also familiar with the concept of installing a small wind turbine, far fewer had actually considered installing one.

The process of installing solar panels on one's home is convenient and straightforward. A modern 6 kW arrangement costs an average of 100,000 DKK (20,000 USD) for a complete package including the panels, and inverter, and the necessary electrical work. The installation process only takes a few days to complete. Handyman-type people may even install the solar panels themselves if they wish to save money and/or customize the installation. Installing wind turbines is also largely straightforward, but wind turbines are subject to much stricter zoning regulations, and every installation must be approved by the local community. The approval process can take 4-6 months to complete. Depending upon the location, some work must be done beforehand to prepare an appropriate foundation for the turbine and to dig a path for the cabling. A modern 6 kW wind turbine is significantly more expensive than comparable photovoltaic solar panels, averaging about 300,000 DKK (60,000 USD) for a complete installation package.

Both photovoltaic solar panels and small wind turbines tend to produce well, but it can be more difficult to estimate the wind energy available in a particular location. Both systems last at least 40 years with little maintenance, but inverters will need replacement roughly every 15 years.

Going Forward

Throughout our analysis, we uncovered two themes that deserve further attention:

First, the policy of net metering leaves much to be desired. As we discussed in the section "Incentive Program Details" in our Results and Discussion, it makes it difficult for people in multi-tenant complexes to install photovoltaic panels. As photovoltaic solar panel installations rise in popularity, the net metering scheme may also adversely reduce income to energy distributors and the government in a manner that cannot be easily adjusted. A feed-in tariff, like the one proposed by the Danish Ecological Council, could address many of these issues. However, we suspect that a feed-in tariff may not be as popular among consumers, because it does not insure against rising energy prices. More work should be done to research and evaluate appropriate incentive programs and how consumers will react to changes.

Second, there is little unbiased information about photovoltaic solar panels and small wind turbines currently available to consumers in Denmark. This lack of information and need for a reliable way to

compare equipment quality were directly mentioned in our interviews with prosumers. There are some existing institutions, such as Energy Service Denmark, which can provide limited advice to consumers, but none of the prosumers we interviewed mentioned consulting the service. We believe that an unbiased source of information about the options that consumers have and the quality of the equipment they can select would be beneficial for consumers and installers alike. More work should be done to consider making this information available and easy for consumers to find.

Appendix A: Interview Questions

Prosumers

Solar Prosumers	Wind Prosumers
<ol style="list-style-type: none"> 1. Before you committed to generating electricity at home, what did you know about the opportunities available to you? 2. What made you decide to generate your own electricity with solar? 3. How did you learn about generating electricity at home? <ol style="list-style-type: none"> a. Who did you seek information from? b. How easy or difficult was it to learn about how one could generate electricity at home? If so, what challenges did you face, and how did you address them? 4. How did you select the equipment you purchased? <ol style="list-style-type: none"> a. What benefits did you expect to receive? b. Who did you purchase your equipment from? c. What challenges did you face when selecting a system to install? How did you address them? 5. Who installed your equipment? <ol style="list-style-type: none"> a. Why did you select this particular installer? b. How long did the installation take? c. How much did the installation cost? d. What challenges did you face when having your equipment installed? How did you address them? e. Overall, how difficult was it to have your equipment installed? Would you say it was easy, hard, or somewhere in between? 6. What role did your utility play throughout this process? <ol style="list-style-type: none"> a. In what ways were they helpful? b. In what ways were they not helpful? 7. How long have you had your equipment? 8. Now that you've had the equipment for a 	<ol style="list-style-type: none"> 1. Before you committed to generating electricity at home, what did you know about the opportunities available to you? 2. What made you decide to generate your own electricity with wind? 3. How did you learn about generating electricity at home? <ol style="list-style-type: none"> a. Who did you seek information from? b. How easy or difficult was it to learn about how one could generate electricity at home? If so, what challenges did you face, and how did you address them? 4. How did you select the equipment you purchased? <ol style="list-style-type: none"> a. What benefits did you expect to receive? b. Who did you purchase your equipment from? c. What challenges did you face when selecting a system to install? How did you address them? 5. Who installed your equipment? <ol style="list-style-type: none"> a. Why did you select this particular installer? b. How long did the installation take? c. How much did the installation cost? d. What challenges did you face when having your equipment installed? How did you address them? e. Overall, how difficult was it to have your equipment installed? Would you say it was easy, hard, or somewhere in between? 6. What role did your utility play throughout this process? <ol style="list-style-type: none"> a. In what ways were they helpful? b. In what ways were they not helpful? 7. How long have you had your equipment? 8. Now that you've had the equipment for a

<p>while, in what ways has it met and/or not met your expectations?</p> <p>9. Now that you have the equipment, have you changed your energy use behavior at home? How so?</p> <p>10. Would you recommend that others purchase similar equipment? Why or why not?</p> <p>11. What would have streamlined the whole experience for you?</p> <p>12. If you were to purchase this or similar equipment again, what would you do differently with the knowledge you now have?</p>	<p>while, in what ways has it met and/or not met your expectations?</p> <p>9. Now that you have the equipment, have you changed your energy use behavior at home? How so?</p> <p>10. Would you recommend that others purchase similar equipment? Why or why not?</p> <p>11. What would have streamlined the whole experience for you?</p> <p>12. If you were to purchase this or similar equipment again, what would you do differently with the knowledge you now have?</p>
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Consumers

Neighbors of Solar Panel Prosumers	Neighbors of Small Wind Prosumers
<p>1. Are you aware that you could generate electricity at home with solar panels?</p> <ol style="list-style-type: none"> Are you aware of any benefits of installing solar panels? Have you heard about this opportunity before? If so, how did you learn about it, and what do you know? <p>2. How much do you think installing solar panels would cost? We don't need an exact or a correct answer, just estimate based on what you know.</p> <p>3. Have you considered installing solar panels on your home?</p> <ol style="list-style-type: none"> If you were to consider or have considered installing solar panels, what type of benefit would be most interesting to you? Some examples are saving money, reducing environmental impact, less dependence upon the electrical grid, etc. If you were to consider installing solar panels, how much money would you be willing to invest on solar panels initially? If you were to consider installing solar panels, within how much time would you expect the system to pay for itself? If you have already considered installing solar panels on your 	<p>1. Are you aware that you could generate electricity at home with a small wind turbine?</p> <ol style="list-style-type: none"> Are you aware of any benefits of installing a small wind turbine? Have you heard about this opportunity before? If so, how did you learn about it, and what do you know? <p>2. How much do you think installing a small wind turbine would cost? We don't need an exact or a correct answer, just estimate based on what you know.</p> <p>3. Have you considered installing a small wind turbine on your home?</p> <ol style="list-style-type: none"> If you were to consider or have considered installing a small wind turbine, what type of benefit would be most interesting to you? Some examples are saving money, reducing environmental impact, less dependence upon the electrical grid, etc. If you were to consider installing a small wind turbine, how much money would you be willing to invest on solar panels initially? If you were to consider installing a small wind turbine, within how much time would you expect the system to pay for itself? If you have already considered

home, why did you choose not to purchase a system for your home?	installing a small wind turbine on your home, why did you choose not to purchase a system for your home?
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Non-Government Organizations

Solar Based NGO's	Wind Based NGO's
<ol style="list-style-type: none"> 1. What is the mission of your organization? 2. What group(s) of people does your organization focus on? 3. Does your organization encourage people to install solar panels on their homes? Why or why not? <ol style="list-style-type: none"> a. If so, how do you encourage or otherwise help people to become involved? 4. What kinds of people usually contact your organization? Why do they contact your organization? 5. Can you recommend any other people or organizations that would be knowledgeable about residential solar panels? 6. Do you know of any people who have had solar panels installed on their home who we could interview? 	<ol style="list-style-type: none"> 1. What is the mission of your organization? 2. What group(s) of people does your organization focus on? 3. Does your organization encourage people to install small wind turbines on their homes? Why or why not? <ol style="list-style-type: none"> a. If so, how do you encourage or otherwise help people to become involved? 4. What kinds of people usually contact your organization? Why do they contact your organization? 5. Can you recommend any other people or organizations that would be knowledgeable about residential small wind turbines? 6. Do you know of any people who have had a small wind installed on their home who we could interview?

Government Organizations

Solar Panel Questions	Small Wind Questions
<ol style="list-style-type: none"> 1. How does home electrical energy generation via solar panels fit into the nation's energy strategy? 2. Has any work been done to analyze the opportunities for home electrical energy generation via solar panels as a significant source of energy? 3. What types of incentives are currently offered to people to generate electricity at home via solar panels, and what kinds are being considered for future implementation? 4. What are the most successful ways to influence consumer behavior, specifically in the energy sector? For example, what kinds of incentives or benefits are most successful in increasing green energy utilization? 	<ol style="list-style-type: none"> 1. How does home electrical energy generation via small wind turbines fit into the nation's energy strategy? 2. Has any work been done to analyze the opportunities for home electrical energy generation via small wind turbines as a significant source of energy? 3. What types of incentives are currently offered to people to generate electricity at home via small wind turbines, and what kinds are being considered for future implementation? 4. What are the most successful ways to influence consumer behavior, specifically in the energy sector? For example, what kinds of incentives or benefits are most successful in increasing green energy utilization?

Equipment Manufacturers and Installers

Solar Panel Manufacturers/Installers	Small Wind Manufacturers/Installers
<ol style="list-style-type: none"> 1. What are the costs and the installation time for an average residential PV System? 2. Do you collect consumer response/interaction data during or after the installation process? We are interested in the type of person who buys this equipment, their motivations for doing so, commonly asked questions and their level of satisfaction in the product. 3. What type of installation do you most often perform? How is it done? 4. What types of incentives or advertising do you use to entice consumers to buy from you? 5. Are there any incentives for consumers with off-grid solar panels connect their solar panels to the grid? 6. In general, what kinds of incentive programs or advertising have worked the best for your company? 7. Does your company have any current plans to expand your incentive programs or advertising? If so, what kinds of incentives do you plan to use and why? 8. Do you know of any consumers or consumer groups which would be willing to speak with us about their experiences using grid-contributing solar panels? 	<ol style="list-style-type: none"> 1. What are the costs and the installation time for an average residential small wind system? 2. Do you collect consumer response/interaction data during or after the installation process? We are interested in the type of person who buys this equipment, their motivations for doing so, commonly asked questions and their level of satisfaction in the product. 3. What type of installation do you most often perform? How is it done? 4. What types of incentives or advertising do you use to entice consumers to buy from you? 5. Are there any incentives for consumers with off-grid small wind to connect their small wind to the grid? 6. In general, what kinds of incentive programs or advertising have worked the best for your company? 7. Does your company have any current plans to expand your incentive programs or advertising? If so, what kinds of incentives do you plan to use and why? 8. Do you know of any consumers or consumer groups which would be willing to speak with us about their experiences using grid-contributing small wind?

Utilities

Solar Panels	Wind Turbines
<ol style="list-style-type: none"> 1. How difficult and/or expensive is it for a consumer to connect solar panels to the grid? How long does this process take? 2. What policies and/or incentives does your company offer to consumers who purchase solar panels and contribute to the grid? 3. How can consumers learn about your prosumerism policies and incentive programs? <ol style="list-style-type: none"> a. Are you advertising these programs? If so, how are you presenting the information, and to whom is it being marketed to? 	<ol style="list-style-type: none"> 1. How difficult and/or expensive is it for a consumer to connect small wind to the grid? How long does this process take? 2. What policies and/or incentives does your company offer to consumers who purchase small wind and contribute to the grid? 3. How can consumers learn about your prosumerism policies and incentive programs? <ol style="list-style-type: none"> a. Are you advertising these programs? If so, how are you presenting the information, and to whom is it being marketed to?

<p>b. May we have samples of your advertisement(s) for these policy and incentive programs?</p> <p>4. In general, what kinds of incentives have you found to produce the best results in changing customer behavior?</p> <p>5. Does your company have any current plans to expand your incentive programs? If so, what kinds of incentives do you plan to use and why?</p> <p>6. Do you know of any consumers or consumer groups which would be willing to speak with us about their experiences using grid-connected renewable energy technologies?</p>	<p>b. May we have samples of your advertisement(s) for these policy and incentive programs?</p> <p>4. In general, what kinds of incentives have you found to produce the best results in changing customer behavior?</p> <p>5. Does your company have any current plans to expand your incentive programs? If so, what kinds of incentives do you plan to use and why?</p> <p>6. Do you know of any consumers or consumer groups which would be willing to speak with us about their experiences using grid-connected renewable energy technologies?</p>
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Appendix B: Survey Questions

What type of housing do you live in?

- (1) Owner-occupied housing (detached, row or detached, etc.)
- (2) Owner-occupied housing (apartment blocks of flats)
- (3) Cooperative property (detached, row or detached, etc.)
- (4) Cooperative (apartment blocks of flats)
- (5) Rented housing (detached, row or detached, etc.)
- (6) Rented housing (apartment blocks of flats)
- (7) Other, please specify: _____
- (8) Will not disclose

Which of the following descriptions best fits the city / area you live in?

- (1) Metropolitan Area
- (2) City (over 100,000 inhabitants) - but not metropolitan area
- (3) Urban areas 50,000-100,000 inhabitants
- (4) Urban areas 10,000-49,999 inhabitants
- (5) Urban areas under 10,000 inhabitants
- (6) Outside urban areas - rural area
- (7) Will not disclose

How large is your household's annual electricity consumption?

- (1) 0 to 1,000 kWh
- (2) 1,001 to 2,000 kWh
- (3) 2,001 to 4,000 kWh
- (4) 4,001 to 6,000 kWh
- (5) 6,001 to 10,000 kWh
- (6) More than 10,000 kWh
- (7) Do not know

Have you installed solar cells connected to your home, or considered it?

- (1) Yes, I have installed solar cells
- (2) Yes, I have considered it but have not (yet) installed solar cells
- (3) No, I have not considered or installed solar cells
- (4) I've never heard of the opportunity to install solar cells

If you have comments on the question, please feel free to write it here (optional):

Where did you hear about the possibility of installing solar cells connected to your home?

- (1) I saw an advertisement from a power company
- (2) I saw an advertisement from a dealer/installer of solar cells
- (3) I attended an information session organized by a power company
- (4) I attended an information session organized by the dealer/installer of solar cells
- (5) I read/heard about it through commercials on TV or radio
- (6) I read about it on the internet
- (7) I heard about it from friends, family, colleagues, etc.
- (8) I heard about it from an tradesman/electrician
- (9) Other, please specify: _____
- (10) Do not remember

What is the reason why you have not installed a solar cells connected to your home - or do not even consider it? You can select multiple answers

- (1) I do not know enough about it
- (2) I do not know who I should contact to buy/install the system
- (3) Solar cells and/or installation costs too much
- (4) The anticipated saving on the electricity bill is too small
- (5) The positive effect on the environment and climate is too small
- (6) The location of my house is not suitable for solar cells
- (7) I am worried about solar cell reliability and/or durability
- (8) Other reasons, please specify: _____

Which of the following factors would be important to you if you were to install solar cells?

You must indicate the most important factor with the number '1', and prioritize the other factors listed from 2 to 6, where '2' indicates the second-most important and '6 ', the least important

The cost of purchasing and installing the PV system is straightforward _____

That I can save on my monthly electricity bill _____

That it has a positive effect on the environment and climate _____

That the cost of the PV system pays for itself quickly by saving on electricity _____

The PV system is reliable/low maintenance _____

That I can guarantee to lower electricity production from the PV system _____

If you have comments on the question, please feel free to write it here (optional):

Have you installed a wind turbine connected to your home, or considered it?

- (1) Yes, I have installed a wind turbine
- (2) Yes, I have considered it but have not (yet) installed a wind turbine
- (3) No, I have not considered or installed a wind turbine
- (4) I've never heard of the opportunity to install a wind turbine

If you have comments on the question, please feel free to write it here (optional):

Where did you hear about the possibility of installing a wind turbine connected to your home?

- (1) I saw an advertisement from a power company
- (2) I saw an advertisement from a dealer/installer of wind turbines
- (3) I attended an information session organized by a power company
- (4) I attended an information session organized by the dealer/installer of wind turbines
- (5) I read / heard about it through commercials on TV or radio
- (6) I read about it on the internet
- (7) I heard about it from friends, family, colleagues, etc.
- (8) I heard about it from the tradesman/electrician
- (9) Other, please specify: _____
- (10) Do not remember

What is the reason why you have not installed a wind turbine connected to your home - or do not even consider it? You can select multiple answers

- (1) I do not know enough about it
- (2) I do not know who I should contact to buy/install the wind turbine
- (3) The turbine and/or installation costs too much
- (4) The anticipated saving on the electricity bill is too small
- (5) The positive effect on the environment and climate is too small
- (6) The location of my house is not suitable for a wind turbine
- (7) I'm worried about the wind turbine reliability and/or durability
- (8) Other reasons, please specify: _____

Which of the following factors would be important to you if you were to install a wind turbine?

You must indicate the most important factor with the number '1', and prioritize the other factors listed from 2 to 6, where '2' indicates the second-most important and '6', the least important

The cost of purchasing and installing the wind turbine is straightforward _____

That I can save on my monthly electricity bill _____

That it has a positive effect on the environment and climate _____

That the cost of the wind turbine pays for itself quickly by saving on electricity _____

The wind turbine is reliable/low maintenance _____

That I can guarantee to lower electricity production from wind turbines _____

Did you know that you can write off the cost of a solar or a wind turbine on your tax return?

(1) Yes

(2) No

Did you know that some energy companies give subsidies to consumers for installing solar panels or putting a wind turbine up?

(1) Yes

(2) No

Have you heard of artisan deduction (also called service allowance)?

(1) Yes

(4) No

Which of the following have you heard of as it applies to artisan deduction?

(1) The deduction is for craftsmen labor, for example, by his installation of solar or wind

(2) The deduction is up to 15,000 kr. per year, for every person over 18 years in the household

(3) The reduction, in its current arrangement expires at the end of 2012

(4) None of the above

Have you heard of the net metering system?

(1) Yes

(2) No

Which of the following have you heard of as it applies to the net metering system?

(1) You have to produce electricity for the grid, e.g. through solar cells or wind turbines?

(4) The solar cells or wind turbine must be no larger than 6kW for each household

(5) You pay no transmission costs or electricity taxes for the amount of electricity you produce

(6) None of the above

How, if at all, would you like to be informed about funding opportunities related to the household production of electricity?

(1) TV Commercials

(2) Radio commercials

(3) Feature in TV, for example in the news, in OBS, etc.

(4) Advertisements on the Internet

(5) Advertisements in newspapers and other print media

(6) Brochures

(7) Information that you can participate in

(8) Individual advice from expert

(9) Other, please specify: _____

(10) I'm not interested in (more) knowledge of funding opportunities

How do you agree with the following statements:

It is important that society and its citizens make an effort to ensure that electricity produced by renewable sources (like wind and solar)

(1) Strongly agree

(2) Agree

(3) Disagree

(4) Strongly disagree

(5) No position

Do you think you have the necessary information to:

	Yes, very much	Yes, to some degree	Only to a lesser extent	No, not at all	Do not know
* Get an overview of products, prices, companies, etc. on the Danish electricity market?	(1) <input type="checkbox"/>	(2) <input type="checkbox"/>	(3) <input type="checkbox"/>	(4) <input type="checkbox"/>	(5) <input type="checkbox"/>
* Choose the electricity product/power company that is best for you?	(1) <input type="checkbox"/>	(2) <input type="checkbox"/>	(3) <input type="checkbox"/>	(4) <input type="checkbox"/>	(5) <input type="checkbox"/>
* Choose/buy the electricity product that has a positive effect on climate?	(1) <input type="checkbox"/>	(2) <input type="checkbox"/>	(3) <input type="checkbox"/>	(4) <input type="checkbox"/>	(5) <input type="checkbox"/>

If you have comments on the information on needs for electricity production products and/or information on electricity companies, please write it here (optional):

What can cause you to become more involved in your power consumption, including finding the company, product, price?

- (1) That I can see my electricity consumption on a screen in the household
- (2) That I can see my electricity consumption (e.g. the last week or month) on a screen
- (3) That I can see electricity consumption via my mobile phone
- (4) That I can produce electricity from renewable energy at my dwelling (e.g. solar or wind)
- (5) That I can produce electricity from renewable energy by other means (e.g. by having wind turbine units at another location)
- (6) That I can buy energy efficient products (refrigerator, washing machine, dishwasher, etc.)
- (7) That I can get the tools/knowledge to change behavior in my home to save energy
- (8) That I can buy electricity from the power companies that promotes sustainable energy
- (9) Other, please specify: _____
- (10) I could not see myself becoming more involved.

Appendix C: Interview Notes

Solar Prosumers

Organization Name:	Solar prosumer
Contact Name:	Simon
Date/Time of Interview:	4/12/12 14:00
<p>1. Before you committed to generating electricity at home, what did you know about the opportunities available to you?</p> <ul style="list-style-type: none"> • Not much; spontaneous decision after hearing about the opportunity from the roof contact • Knew about the general idea, but not much about the technical information • Newspapers had <i>some</i> articles about energy savings devices • Surprised about the number of panels required; thought 1 or 2 would be enough <p>2. What made you decide to generate your own electricity?</p> <ul style="list-style-type: none"> • Had to change the roof; expensive to set up scaffolding • Their roof is faced to the south, so it was easy to get an optimal installation • Reduction on the electricity bill • Environmentally friendly; “the right thing to do” <p>3. How did you learn about generating electricity at home?</p> <ul style="list-style-type: none"> • There is a lot of “positive energy, or positive information about solar energy or other types of natural energy” • <u>The government likes to promote renewable energy; more wind power</u> • Idea came from the provider of the roof; solar was easier to do at the same time <p>a. Who did you seek information from?</p> <ul style="list-style-type: none"> • Mainly from articles on the web; technical websites. Also newspapers Scientific papers • “Dug down to read about it” • Talked to a colleague had a summer house with solar panels <p>b. Did you find it difficult to learn about how one could generate electricity at home? If so, what challenges did you face, and how did you address them?</p> <ul style="list-style-type: none"> • “It’s not easy enough for people who don’t know about this technique. You have to read about different types of equipment.” • You can go to warehouses or supermarkets and buy solar panels. “People don’t know what they are doing”. People don’t know how to choose appropriate panels. • <u>“There should be independent information...there should be some public recommendation”</u> • It’s dangerous to do it yourself if you don’t know what you’re doing. • They can’t install the panels when it’s raining, because the panels will start producing once they are out of the box • A friend could see how many people have destroyed their houses by using the 	

wrong materials and such. “People are financially motivated to do it themselves and they destroy it”.

4. How did you select the equipment you purchased?

a. Was there a reason you selected a 4 kW device instead of 6?

- They were told to select a device smaller than their consumption to avoid “problems” with net generation.
- Extra cost
- Shadow from trees
- The shape of the roof may have also had an effect.
- Solar installer recommended a 4 kW device; “they did the calculations”.

b. What benefits did you expect to receive?

- Monetary benefits
- “Good feeling”
- “Good attitude, good signal to send, and to inspire somebody else”

c. Who did you purchase your equipment from?

- Weibel – installer
- Zeteco – panel manufacturer (from China), Concerned about quality, given guarantee

d. What challenges did you face when selecting a system to install? How did you address them?

- Wondered whether they made the right decision. Doesn’t know whether there will be extra costs in the future
- Thought at first that they would use the advanced tax rule (small business). But they chose to use net metering instead.
- Installer didn’t even know all the tax rules; the solar manufacturers did. “They didn’t want to set up a service contract, because they didn’t know enough about it”
- If you ask the state tax people a question, then their answer is solid the next 5 years

5. Who installed your equipment?

- Weibel

a. Why did you select this particular installer?

- They have a guy who advised them on the roof; i.e. how to build the roof, and this would affect the solar panel installation. This consultant recommended Weibel.
- Weibel is working directly with the Bergmann’s.

b. How long will the installation take?

- Approx. 2 weeks

c. How much did the installation cost?

- Approx. 90,000 DKK before reductions from the electricity provider

- Electricity utility will save on their CO2 budget; they will pay for the solar panels and improved insulation (approx. 3,000 DKK)

- d. **What challenges did you face when having your equipment installed? How did you address them?**
 - The roof installers and the solar panel installer have to work together
 - On the south side, they have to install some devices to hold the solar panels
 - The project started up 2 weeks late since the panels arrived late, interfered with the holiday
 - e. **Overall, how difficult was it to have your equipment installed? Would you say it was easy, hard, or somewhere in between?**
 - Easy. "They have a very good consultant, the enterprise for the roof is very skilled"
 - "They are very good guys."
 - "[Wieber] is very enthusiastic to learn about it and work with the other guys"
6. **What role did your utility play throughout this process?**
 - Weibel has worked with their utility. They have reported that they would like to receive a CO2 reduction under the tax code.
 7. **How long have you had your equipment?**
 - Not yet installed.
 8. **Now that you've had the equipment for a while, in what ways has it met and/or not met your expectations?**
 - N/a – Not installed yet
 9. **Now that you have the equipment, have you changed your energy use behavior at home? How so?**
 - They do not plan to change their usage; "it is important to keep the same pattern"
 10. **Would you recommend that others purchase similar equipment? Why or why not?**
 - "Certainly." "Great potential worldwide for this kind of thing"
 - The market for it is coming.
 - "Pioneers;" first on the street to get solar panels
 11. **What would have streamlined the whole experience for you?**
 - "If we were not pioneers. If we had some good examples of solar panels, choices, tax rules"
 - There are a few installations around, so having some existing examples to look at would help a lot.
 - Advice: Have a good consultant
 12. **If you were to purchase this or similar equipment again, what would you do differently with the knowledge you now have?**
 - They feel that they don't benefit enough from the falling solar panel prices.

- They would get information and quotes from other vendors; shop around a little
- It's a matter of how much time they want to put into it

Other Discouraging Factors:

- It depends on what is need for the house initially (i.e. windows, insulation, other). Solar is not always considered "needed."
- Looks of panels on the house

Interviewee-Specific Questions

Are there any neighbors of yours who we could contact?

- Yes

Extra notes

- Motivators:
 - Environmental stewardship
 - Son said "YES!!"
 - Economic factors
- They were replacing the roof, so they decided to install solar panels at the same time
- In 30 yrs, the solar panels & the roof work will be paid off
- Mindful of impact to value of house
 - Could have purchased a black roof, chose not to because red was the original color
- Considering where to install the inverter on the roof
 - Concerns about heat affecting the production and lifetime of the inverter
 - Inverters have little ventilators
- Electricity prices
 - CO2 tax + VAT causes rise in price
- After 8 years, they will make money; After 30, they will break even
- Found websites themselves
 - Most uncertain about good tax information
- Solar panels will warm slightly as they operate; this will melt snow
- At the moment, the grid cannot accept distributed power at a size > 6 kW; when wires are put buried, this may be an option in the future
- They were somewhat concerned that their Chinese panels would last
 - It was important to them that the Germans have already tested them

Organization Name:	Solar Prosumer
Contact Name:	Valter
Date/Time of Interview:	2/19/12 11:00
<p>1. Before you committed to generating electricity at home, what did you know about the opportunities available to you?</p> <ul style="list-style-type: none"> • First heard about from skiing trips to Norway many years ago; houses in the mountains had small solar panels • Saw some small devices along the roads; weather and phone stations • Solar panels around his area are mostly solar heating 	

- Saw an Ad about a new law that decided that the Danish suppliers of electricity were forced to provide net metering; 6 kW rated capacity
 - When the law was passed, they were more expensive; prices have been going down
- Started looking at the opportunities; looked into pricing
- Investigated the effect that the Danish climate would have on the panel; speculation about the quality of the panels from the China
- When first interested - he has a friend who installed it on a summer house; the friend had a contact in the industry
- Also has a neighbor that purchased a system from Living Energy; his friend was an electrical engineer, so Valter trusted his choice. Chose an inverter that had enough ~15 A connections to supply his home
- Economics - guarantee that you have a supply in the summer, surplus can be sold
“the economy lies in the fact that you reduce the taxes when you do it”

2. What made you decide to generate your own electricity?

- He had the money
- “it’s like a political statement”
- “It’s evident that solar energy will be the answer, finally”
- “you do not enter into anything until the profit is there”
- “that’s a general attitude that we have to change” referencing an anecdote that a company said it was too expensive to clean pollution put in some rivers that ended in the red sea
- “solar panels have to get into it eventually” talking about government aims to use wind and intelligent grid to move away from fossil fuel
- “in the future we will have to employ these things” solar panels and conversion of surplus energy to storable energy

3. How did you learn about generating electricity at home?

- Was an engineering student for a few years; understands the principles of how the cells work
- Friend is an electrical engineering background, and neighbor made the process a lot easier

a. Who did you seek information from?

- Friend with the summer house, neighbor, and personal background
- The internet
- Surprised to see how large the market is for solar panels

b. Did you find it difficult to learn about how one could generate electricity at home? If so, what challenges did you face, and how did you address them?

- Part of it was straightforward; the superficial principle is easy
- Looking into the inverter technology becomes more complicated
 - Selected inverter based on neighbors recommendations
 - A company told a sales agent to tell people that inverters would only work with a certain number of panels; they wanted to make selling packages simple

4. How did you select the equipment you purchased?

- Talked to his neighbor and decided it would be easier to compare their equipment performance if they had the same equipment

- a. **What benefits did you expect to receive?**
- Right way to produce electricity
 - “right thing to do”
 - In 8-9 years he payback and would have free electricity
- b. **Who did you purchase your equipment from?**
- Living Energy
- c. **What challenges did you face when selecting a system to install? How did you address them?**
- Find out from the authorities whether you can install the panels or not; they determine how things should look, the angles of things, etc.
 - Uncertainty in the investment
 - Willing to take the risk in speculating about the performance and quality of equipment
 - Look of system on roof was important
 - Overall discouraging factor - wrong roof direction would need more panels and cost more money (Neighbor was interested but wrong roof direction)
5. **Who installed your equipment?**
- Living Energy Electrician Installer
- a. **Why did you select this particular installer?**
- They looked at Gaia-Solar first
 - Told him that they had to install a certain number of panels (not true)
 - Too expensive
 - There is a website where you can look up the panels and find the standards for them
 - Most concerned about the cases for the panels “will they keep up with the rough weather”
 - If anything goes wrong, he doesn’t have to talk to anyone else beyond Living Energy
- b. **How long did the installation take?**
- They worked for 4 days, not all of the time
 - Day 1 and 2 - Two panel installers
 - Day 3 - Electrician for wiring and inverter
 - Day 4 - The electrician did it wrong, so they had to re-do it on the last day
 - The panels have to be arranged to generate a minimum of 180 volts
 - Not more than 3 meters up from the ground so did not have to put up scaffolding
 - Walking around on tiles isn’t easy; installers broke a few.
- c. **How much did the installation cost?**
- | | |
|--------------|--------------------|
| Equipment | 78.400 dkk |
| Install | 26.100 dkk |
| Rebate | 3.100 dkk |
| Paying cash | 1.200 dkk |
| Total | 101.400 dkk |

- Tax deduction for the worker wages; he and his wife split up the deductions
- d. What challenges did you face when having your equipment installed? How did you address them?**
- Electrician did not wire correctly – See above
 - Had some trouble connecting computers to the inverter to get the production information off of it
 - Wanted to get a more advanced smart meter, but the utility wouldn't install it. Once a year, he reports the status of the meter
- e. Overall, how difficult was it to have your equipment installed? Would you say it was easy, hard, or somewhere in between?**
- In between
 - Lots of time spent investigating things; “has to be a hobby”
 - Have to wait for the panels to be delivered; a matter of a few weeks
- 6. What role did your utility play throughout this process?**
- Living Energy took care of it.
- a. In what ways were they helpful?**
- N/a
- b. In what ways were they not helpful?**
- They did not acknowledge the presence of the panels; he had to call and check
- 7. How long have you had your equipment?**
- Since January 24 2012
- 8. Now that you've had the equipment for a while, in what ways has it met and/or not met your expectations?**
- It's met his expectations - In ideal circumstances, his panels generate 4200 watts
- 9. Now that you have the equipment, have you changed your energy use behavior at home? How so?**
- Don't need to worry about turning off the lights as much because it doesn't matter
 - Became more aware of running appliances and other household utilities
 - For example: used to keep the coffee machine running all the time; now he turns it off when he doesn't expect to use it
 - **You're more conscientious because it's easy to see your usage**
 - “Yes. It's easy to see what uses the most energy with the meters.”
- 10. Would you recommend that others purchase similar equipment? Why or why not?**
- Yes.
- 11. What would have streamlined the whole experience for you?**
- Nothing – like the way he did it
 - Noticed that a large supermarket chain now advertises solar systems; he wouldn't go to a supermarket for panels

12. If you were to purchase this or similar equipment again, what would you do differently with the knowledge you now have?

- He would still go to Living Energy. If something *had* been wrong, we would go to another company
- He looked into a heat pump, but the bricks in his house are solid bricks and the walls are not wide enough. Also, the windows and home insulation would have to be efficient enough; the old system requires hotter water than the heat pump would provide.
- They have an old gas heater; so they are looking into replacing it, but a heat pump system would cost as much as a set of panels

Interviewee-Specific Questions**We heard from other people that they got a carbon credit from their utility for the installation; have you gotten anything like this?**

- No, but utility will reduce electricity bill each year

Would you be willing to introduce us to some of your neighbors, and send us their contact information if they are interested in talking with us?

- Yes – will email contacts

Extra notes

- Hired a mason to help with the brick work and an electrician to help with the wiring, but did other things himself
- Had a professional install the panels in order to prevent cracking of the porous ceramic roof in the winter
- They had a problem on a nice day where the inverters went down for an hour and then came back online
 - No explanation from the utility or installer
- People rent roofs from farmers and people in rural areas

Organization Name:	Solar Prosumer
Contact Name:	Egon
Date/Time of Interview:	4/23/12 08:30
1. Before you committed to generating electricity at home, what did you know about the opportunities available to you? <ul style="list-style-type: none"> • Learned about it from his coworkers in Ostkraft • He is an electrician. 	
2. What made you decide to generate your own electricity? <ul style="list-style-type: none"> • Installed panels for fun. Interesting in the market. <u>Money was not a main factor</u> 	
3. How did you learn about generating electricity at home? <ul style="list-style-type: none"> • Read about it, worked with 5 other people in the firm. <u>Through it would be a good idea to</u> 	

- compare experiences/systems with other people.
 - Also used the internet as a resource
 - a. **Who did you seek information from?**
 - See above. Questions #3
 - b. **Did you find it difficult to learn about how one could generate electricity at home? If so, what challenges did you face, and how did you address them?**
 - No.
4. **How did you select the equipment you purchased?**
- A firm/retailer on Bornholm advised him about the systems he could install.
 - a. **What benefits did you expect to receive?**
 - Expected about 10,000 kWh/year
 - b. **Who did you purchase your equipment from?**
 - Local firm/retailer
 - c. **What challenges did you face when selecting a system to install? How did you address them?**
 - None; worked with coworkers.
5. **Who installed your equipment?**
- Installed his own equipment and had an electrician do the grid connection (required)
 - a. **Why did you select this particular installer?**
 - It was the only one available under a particular pay back scheme with Ostkraft
 - b. **How long did the installation take?**
 - Less than half a day
 - c. **How much did the installation cost?**
 - 23,000 DKK
 - d. **What challenges did you face when having your equipment installed? How did you address them?**
 - No challenges with installation
 - e. **Overall, how difficult was it to have your equipment installed? Would you say it was easy, hard, or somewhere in between?**
 - Easy
6. **What role did your utility play throughout this process?**
- No; the solar panel retailer arranged this.
 - a. **In what ways were they helpful?**
 - N/a
 - b. **In what ways were they not helpful?**

- N/a

7. How long have you had your equipment?

- Since August 2011
- Approx. 8 months

8. Now that you've had the equipment for a while, in what ways has it met and/or not met your expectations?

- Has met expectations. Generated as much electricity as expected.

9. Now that you have the equipment, have you changed your energy use behavior at home? How so?

- Not at all.

10. Would you recommend that others purchase similar equipment? Why or why not?

- Yes; he told his neighbor, who used the same firm to buy a solar system

11. What would have streamlined the whole experience for you?

- Nothing

12. If you were to purchase this or similar equipment again, what would you do differently with the knowledge you now have?

- Nothing

Interviewee-Specific Questions

- N/a

Extra Notes

- 7x 200 watt panels = 1.4 kW

Organization Name:	Solar Prosumer
Contact Name:	Frankie
Date/Time of Interview:	4/23/12 09:30
<p>1. Before you committed to generating electricity at home, what did you know about the opportunities available to you?</p> <ul style="list-style-type: none"> • Looked at wind turbines and water turbines (didn't have water though). • <u>Found that solar panels prices were going down.</u> <p>2. What made you decide to generate your own electricity?</p> <ul style="list-style-type: none"> • <u>The price, and it's fun to generate his own electricity</u> <p>3. How did you learn about generating electricity at home?</p> <ul style="list-style-type: none"> • From working at Ostkraft • <u>The internet</u> 	

- a. **Who did you seek information from?**
 - See above. Questions #3
- b. **Did you find it difficult to learn about how one could generate electricity at home? If so, what challenges did you face, and how did you address them?**
 - No. He was an educated mechanic so has a technical background
4. **How did you select the equipment you purchased?**
 - Got some offers from dealers on Bornholm. Wanted to try a small system first before upgrading to a larger system
- a. **What benefits did you expect to receive?**
 - Smaller bill from the power plant
 - Fun experience. “It’s almost like a scientific experiment in my backyard”
- b. **Who did you purchase your equipment from?**
 - Local dealer in Roenne.
- c. **What challenges did you face when selecting a system to install? How did you address them?**
 - Looked for panels that would provide the most power output for the smallest size, so that they could be turned into the sun.
5. **Who installed your equipment?**
 - Mostly himself. Electrician hired for the electrical connections.
- a. **Why did you select this particular installer?**
 - N/a
- b. **How long did the installation take?**
 - 2 hours; installed on the ground.
Custom build sun tracking system is not finished; took 1.5 days to weld track.
- c. **How much did the installation cost?**
 - 6,000 DKK
- d. **What challenges did you face when having your equipment installed? How did you address them?**
 - Digging a big center hole for the panels to rotate around; wind and such.
- e. **Overall, how difficult was it to have your equipment installed? Would you say it was easy, hard, or somewhere in between?**
 - Easy
6. **What role did your utility play throughout this process?**
 - No.
- a. **In what ways were they helpful?**
 - N/a

- b. In what ways were they not helpful?**
- N/a
- 7. How long have you had your equipment?**
- About 1 year
- 8. Now that you've had the equipment for a while, in what ways has it met and/or not met your expectations?**
- More energy conscious. Try and save energy when possible by turning off appliances and lights
- 9. Now that you have the equipment, have you changed your energy use behavior at home? How so?**
- People turn off lights, use appliances and computers less, etc.
- 10. Would you recommend that others purchase similar equipment? Why or why not?**
- It's fun
 - Save money on electrical bill
 - Take care of the environment, it's a good thing to do
 - Recommends to others to build a tracking system instead of buying one (too expensive)
- 11. What would have streamlined the whole experience for you?**
- If a cheaper solar panel turning mount was available, hey would buy it
- 12. If you were to purchase this or similar equipment again, what would you do differently with the knowledge you now have?**
- He would buy a panel in Germany for much cheaper; don't need to pay taxes when returning to Denmark. Would have almost 50% to buy in Germany

Interviewee-Specific Questions

You planned early on to turn your panels towards the sun?

- Yes.

Did you consider purchasing a tracking system instead of building one?

- Too expensive; it would take too long to pay off the investment.

You're planning to upgrade your system?

- Yes. 1 kW every winter, up to a total of 6 kW.

Which country did your solar panels come from?

- Probably China. Lots of taxes from purchasing within Denmark.

Extra Notes

- 1.5 kW, self-make pointing mechanism
- Bought a 10 kW turbines 12 yrs ago, but never raised it
- Bought a 3 kW inverter to allow for future expansion

Organization Name:	Solar Prosumer
Contact Name:	Peter
Date/Time of Interview:	April 23, 2012 at 11:00 AM
<p>1. Before you committed to generating electricity at home, what did you know about the opportunities available to you?</p> <ul style="list-style-type: none"> • Interested in the topic for about 10 years • Solar heaters & panels • High initial price; needed a buffer <p>2. What made you decide to generate your own electricity?</p> <ul style="list-style-type: none"> • To do it in a green way • Family background is German • Mining in his home town; wanted to reduce pollution in the environment • Fascinated by all of the wind mills in Denmark <p>3. How did you learn about generating electricity at home?</p> <ul style="list-style-type: none"> • First, he searched on his own • He also got some information from Ostkraft <p>a. Who did you seek information from?</p> <ul style="list-style-type: none"> • Ostkraft, Installers <p>b. Did you find it difficult to learn about how one could generate electricity at home? If so, what challenges did you face, and how did you address them?</p> <ul style="list-style-type: none"> • No. <p>4. How did you select the equipment you purchased?</p> <ul style="list-style-type: none"> • Talked with some different companies in Germany who were working with it • Picked the company who gave him the best help and a good price • Worked with EnergyMiDT with the Ostkraft demonstration home. <p>a. What benefits did you expect to receive?</p> <ul style="list-style-type: none"> • Economics of the investment • More environmentally conscious <p>b. Who did you purchase your equipment from?</p> <ul style="list-style-type: none"> • A company in Germany; little company • Solar panels are from China • European inverter • Demonstration house solar panels from EnergiMiDT, Chinese panels. <p>c. What challenges did you face when selecting a system to install? How did you address them?</p> <ul style="list-style-type: none"> • Yes and no. He had some trouble synchronizing the grid frequency with his Austrian inverter, which would cause the panels to stop producing. 	

5. Who installed your equipment?

- He installed it himself + hired an electrician to connect to the grid

a. Why did you select this particular installer?

- He was an engineer and wanted to.

b. How long did the installation take?

- A whole weekend; i.e. 24 hours

c. How much did the installation cost?

- Company house: 90,000 DKK all inclusive
- Personal home: 150,000 DKK
- Costs < 100,000 DKK now

d. What challenges did you face when having your equipment installed? How did you address them?

- Not really; made the installation stronger than necessary to withstand storms better.

e. Overall, how difficult was it to have your equipment installed? Would you say it was easy, hard, or somewhere in between?

- Very easy. Every person who is a handyman can do it without problems. The electrical connections require help.

6. What role did your utility play throughout this process?

- Yes; he only worked with them to resolve the frequency problem with the grid.

a. In what ways were they helpful?

- N/a

b. In what ways were they not helpful?

- N/a

7. How long have you had your equipment?

- Company: August 2009
- Private: June, 2010

8. Now that you've had the equipment for a while, in what ways has it met and/or not met your expectations?

- Did not expect anything when he started; would buy a system and see how much it would produce
- Average production
- 4000 kWh/year

9. Now that you have the equipment, have you changed your energy use behavior at home? How so?

- Yes. Reduce consumption in order to balance his net usage to 0.
- Not a huge difference, but some

10. Would you recommend that others purchase similar equipment? Why or why not?

- Yes. Good material, inverter is good, nothing he would do differently

11. What would have streamlined the whole experience for you?

- It is difficult in lots of areas on Bornholm to install solar panels. There are people who like to preserve the look of older houses.
- It would be a lot easier to install panels if this was not the case.
- He believes that people have to move forward

12. If you were to purchase this or similar equipment again, what would you do differently with the knowledge you now have?

- In general, nothing to change. Would buy the best panels he could get, but nothing else.
- On his private house, the roof is not optimal
- The non-optimal roof is producing more than expected, and the optimal roof is not producing as much as expected

Interviewee-Specific Questions**When you were learning about the opportunities with solar, did you have any problems with tax incentives?**

- No.

Extra notes

- 2 homes on Bornholm
 - Personal home has solar panels
 - 6 kW, self sufficient
 - Company demonstration home has solar panels and small wind turbine
- His company is one of the few companies that is authorized to install solar systems
- His company started with solar heaters, moved into the PV industry

Organization Name:	Solar Prosumer
Contact Name:	Ronny
Date/Time of Interview:	04/23/12 09:45
1. Before you committed to generating electricity at home, what did you know about the opportunities available to you? <ul style="list-style-type: none"> • Knew the general concept; heard some general information from a coworker 	
2. What made you decide to generate your own electricity? <ul style="list-style-type: none"> • Mostly because they use a lot of electricity for warming. They have a small heat pump and a large heat pump. They purchased solar panels to help offset this cost. 	
3. How did you learn about generating electricity at home? <ul style="list-style-type: none"> • On the internet – “My meter can run backwards” concept 	
a. Who did you seek information from?	

- He and another coworker are in a community; they purchased a bunch of solar panels as a group to minimize the cost of shipping in the solar panels. They had 5 people.

b. Did you find it difficult to learn about how one could generate electricity at home? If so, what challenges did you face, and how did you address them?

- No. It was fairly straightforward to look up things on the internet. Needed a phone consult for the tax information.

4. How did you select the equipment you purchased?

- Quality, efficiency (how much you can get out of every panel).
- a. What benefits did you expect to receive?**
- Only a small panels, 1000 kW. Get in on solar panels now, wait for more efficient panels later.
- b. Who did you purchase your equipment from?**
- A little electric firm on Bornholm. Chosen for best quality and price.
- c. What challenges did you face when selecting a system to install? How did you address them?**
- He expected that it could run his house independently from the grid, but that was not possible.

5. Who installed your equipment?

- Small electric firm on Bornholm.
- a. Why did you select this particular installer?**
- See above. Question #5
- b. How long did the installation take?**
- 5 hours to install the panels on the roof, 1 hour to wire it.
- c. How much did the installation cost?**
- 36,000 DKK
- d. What challenges did you face when having your equipment installed? How did you address them?**
- None
- e. Overall, how difficult was it to have your equipment installed? Would you say it was easy, hard, or somewhere in between?**
- Easy.

6. What role did your utility play throughout this process

- Didn't play a role
- a. In what ways were they helpful?**
- N/a

- b. In what ways were they not helpful?**
- N/a
- 7. How long have you had your equipment?**
- Last August (2012)
- 8. Now that you've had the equipment for a while, in what ways has it met and/or not met your expectations?**
- Installer gave him a mid-range inverter, which cannot handle 10 panels; the inverter shuts down at some points during the day. He needs a new one.
- 9. Now that you have the equipment, have you changed your energy use behavior at home? How so?**
- No. They were already conscious of their usage.
- 10. Would you recommend that others purchase similar equipment? Why or why not?**
- Yes. You can reduce the impact of CO₂, reduce the cost of electricity.
"They had to do something" to help reduce the nation's oil usage.
 - He would recommend larger systems for other people.; he got a small system and plans to install more panels later.
- 11. What would have streamlined the whole experience for you?**
- Nothing
- 12. If you were to purchase this or similar equipment again, what would you do differently with the knowledge you now have?**
- Go bigger. Buy the biggest inverter you can, and then add panels on.

Interviewee-Specific Questions

Do you know where your solar panels came from?

- No. France, possibly.

Was it easier to talk to your coworkers?

- Yes. Exchanged information with each other, helped avoid mistakes.

Have you started to plan adding panels to your roof yet?

- Yes. If they can work out a deal with their retailer to get a new inverter, he will buy more panels.

How would you want information about this opportunity presented?

- Phone, Mail, Internet, anything.

Extra Notes

- Installed solar panels on roof himself
- Thinking of purchasing an air to water heat pump; currently, their heat pumps heat their rooms
- Could not import a bunch of small wind turbines from the US
 - Too expensive in taxes
- Would only consider installing small turbines; doesn't want to bother neighbors
- Found tax information online; called tax office for questions

Wind Prosumers

Organization Name:	Wind Prosumer
Contact Name:	Stig
Date/Time of Interview:	4/24/12 10:00

- 1. Before you committed to generating electricity at home, what did you know about the opportunities available to you?**
 - Spent the last 3-5 years collecting information
 - Looked into solar panels and wind turbines
 - Deep and shallow geothermal heating are available
- 2. What made you decide to generate your own electricity?**
 - “We have to do something” about environmental concerns
Economics
- 3. How did you learn about generating electricity at home?**
 - Spent 3-5 years researching
 - a. Who did you seek information from?**
 - A local wind turbine club/cooperative
 - Internet
 - Reading books
 - Attended a Zeteco lecture
 - b. Did you find it difficult to learn about how one could generate electricity at home? If so, what challenges did you face, and how did you address them?**
 - No.
 - Not into all of the technical details, but you don’t have to be.
- 4. How did you select the equipment you purchased?**
 - He heard good things about the wind mill
 - Went to Zealand to look at an existing installation
 - Talked with Zeteco
 - He and his girlfriend didn’t like the design of other turbines (guy wires, etc.)
 - Used the business model of taxes to pay of the turbine
 - a. What benefits did you expect to receive?**
 - “Mostly the idea that I can say ‘we make our own energy, come and have a look’”
 - b. Who did you purchase your equipment from?**
 - EcoWind
 - c. What challenges did you face when selecting a system to install? How did you address them?**
 - If the earlier governments were less conservative, then they would have been

able to get in earlier

5. Who installed your equipment?

- EcoWind

a. Why did you select this particular installer?

- Liked the turbine, heard good things about them

b. How long did the installation take?

- 8 weeks to get approval from the local neighborhood council
- 1 week digging + laying cables
- 1 day to prepare the foundation (done by himself with friends)
- 1 day to install the turbine (done by EcoWind)

c. How much did the installation cost?

- 450,000 – 110,000 DKK
- Got a low-interest loan

d. What challenges did you face when having your equipment installed? How did you address them?

- Nothing really
- The concrete/cement guy didn't want to drive up to his turbine location on the grass

e. Overall, how difficult was it to have your equipment installed? Would you say it was easy, hard, or somewhere in between?

- Easy.

6. What role did your utility play throughout this process?

- Had an old digital one; had to get a newer digital one installed
- Rented the new meter from Ostkraft

a. In what ways were they helpful?

- Straightforward.

b. In what ways were they not helpful?

- They ran out of meters when he had to get his installed; they are not stocked because they are only used for wind turbines. Had to wait ~2 weeks

7. How long have you had your equipment?

- Approx. 6 months

8. Now that you've had the equipment for a while, in what ways has it met and/or not met your expectations?

- Very happy.
- Producing quite well.
- He expects a net usage of around 0.

9. Now that you have the equipment, have you changed your energy use behavior at home?

How so?

- No.
- They were already energy conscious.

10. Would you recommend that others purchase similar equipment? Why or why not?

- Yes. You get the most economic benefit from using the energy yourself; combined with a heat pump or geothermal, it makes sense to offset the cost.

11. What would have streamlined the whole experience for you?

- Nothing.

12. If you were to purchase this or similar equipment again, what would you do differently with the knowledge you now have?

- Install it during a dry season period.
- A hydraulic tower is now available; might consider it if he were installing it now, but could be expensive

Interviewee-Specific Questions**Why did you choose wind over solar?**

- Got a price of ~150,000 DKK for 6 kW solar panels; was told this would produce a max of 5700 DKK
- His turbine will produce about 12,000 kWh
- Said he'd consider solar panels if he purchased an electric vehicle

Was the cost of transporting the turbine to Bornholm from the mainland significant?

- Not really; extra 5000 DKK

Extra notes

- Nearest neighbor is ~300 meters away
- Before they improved the house, they used a lot of oil
 - 1000 L / month in the winter
- Also installed a heat pump to replace the oil boiler
- 6 kW wind turbine
 - 15 meters tall, ~ 18 to the tip
- 110,000 DKK for heat pump

Organization Name:	Wind Prosumer
Contact Name:	Lars
Date/Time of Interview:	4/23/12 13:40
1. Before you committed to generating electricity at home, what did you know about the opportunities available to you? <ul style="list-style-type: none"> • Followed legislature closely until June 2010 • Waited for net metering before installing a turbine 	

2. What made you decide to generate your own electricity?

- He finds the idea of green power interesting
- Planning to buy solar panels at some point in the future, is hoping for future panels to have a higher efficiency.

3. How did you learn about generating electricity at home?

- Working at Ostkraft (Coworkers)
- Google

a. Who did you seek information from?

- See above. Question #3

b. Did you find it difficult to learn about how one could generate electricity at home? If so, what challenges did you face, and how did you address them?

- No, it was not difficult
- Magazines had a lot of ads for home wind turbines

4. How did you select the equipment you purchased?

- Limited to an overall height of 10 meters to tip of blade.
- If the turbine is more than 100 meters from the house, then net metering does not apply.
- Didn't want anything from China; bought one made in Europe
- Not many are approved in the market for Denmark; only about 10-15

a. What benefits did you expect to receive?

- Low cost
- Green energy

b. Who did you purchase your equipment from?

- Local firm on Bornholm

c. What challenges did you face when selecting a system to install? How did you address them?

- Size was limited due to regulations on height and location

5. Who installed your equipment?

- Self-installed, hired an electrician to connect it

a. Why did you select this particular installer?

- N/a

b. How long did the installation take?

- Quite a while, had to dig in the cables
- Had to go all the way under the house with the cabling

c. How much did the installation cost?

- Turbine, brakes, + inverter = 40,000 DKK
- Total = 50,000 DKK
- Got a discount from the dealer for working with Ostkraft

Interviewee-Specific Questions

- N/a

Extra notes

- 3 kW wind turbine
- 8 meters high
- His house is high up; 6x the height to the nearest neighbor
- Can get 25% off when you buy through Ostkraft

Organization Name:	Wind Prosumer
Contact Name:	Hugo
Date/Time of Interview:	Email Response
<p>1. Before you committed to generating electricity at home, what did you know about the opportunities available to you?</p> <ul style="list-style-type: none"> • As a young journalist in the 1970s I had the opportunity to interview the first turbine builders of the new generation that created today's wind adventure in Denmark. I was also an eyewitness to the construction of Tvind mill and have always been interested in wind energy - my great-grandfather himself had a large windmill in the middle of the 1800s and has been much talk in my family. <p>2. How did you learn about generating electricity at home?</p> <ul style="list-style-type: none"> • See Above. Questions #1 <p>3. Why did you decide to purchase a small wind turbine?</p> <ul style="list-style-type: none"> • For anyone interested in wind energy is, however, that there must be some money in it before you invest in an energy plant. For me, it happened that the floor heat in my old house was leaking in 1982. The insurance company advised me to retiring oil heating and get electric heating throughout the house. The insurance paid for reorganization, and back then it was cheaper to heat up the house with electricity than with oil. However, it was reversed during the '90s, where the price of electricity increased by several times. <p>4. How did you select the equipment you purchased?</p> <ul style="list-style-type: none"> • At a Christmas party in 1997 told my neighbor, he negotiated with the company, Gaia-Wind to buy their 11 kWh turbine. I saw his project and he noted that in addition to savings in their own consumption of electricity would also be a small profit. Therefore I bought a Gaia-mill. The company took care of the municipal building permit, and together with the local power company mill was erected and connected to the grid on 18 august 1998 - four months after signing the contract. <p>a. How long did it take to install?</p> <p>b. How much did it cost to install?</p> <ul style="list-style-type: none"> • It would provide a payback period of the mill over seven years at a mill price of 320,000 dkk 	

- Installation costs were included in the total price and was for 12,000 kr.

5. Is your small wind turbine connected to the electrical grid?

- Yes

6. Who did you purchase your equipment from?

- Gaia Wind

7. How long have you had your small wind turbine?

- 13 years (since 1999)

8. Now that you've had the equipment for a while, in what ways has it met and/or not met your expectations?

- My expectations have been largely met. Repayment period can be difficult to determine because it includes some very complex technical tax calculations. Already at the layout of the mill gave Gaia-Wind indication that we are in so long would get a "back-meter" that the new mini-mills up to 6 kWh was authorized in 2010 - it would have given me a much better economy for the last 14 years, but the opportunity we have not received yet.

9. If you were to purchase a small wind turbine again, what would you do differently?

- If I were to buy a new turbine today I would probably buy a 25 kWh turbine, which could cover a larger portion of my electricity consumption of 26,000 kWh - 11 kWh turbine covers approx. 60%, equal to 18.0000 kWh of annual production of 33,000 kWh - but I can also hope that I get a backflow meter, as my problem would be solved.
- A 11 kWh household mill today costs about DKK 500,000 and to recoup itself, one must have an annual consumption of at least 15,000 kwh. The mill will produce between 30,000 and 35,000 annually.
- General information on household mill owners, I can say that it is people in the country - with a small farm or a former farm with electricity
- There ca. 180 small windmills on 11 and 25 KWK in Denmark today. In the early 1990s had an expectation that he number would reach about 3500, but the tax system, the relatively expensive mills and tight municipal rules for the establishment of household turbines stopped development. In addition, utilities No special flexibility, because they considered the cost of connection to the network and billing to be too large in relation to what the turbines could contribute.
- In 2011, there was a large number of 6 kWh turbines sold as a result of new tax and backflow meters for this type of mills, which allegedly could produce up to 15,000 kWh per year - neither number of new mills or production figures are, however, documented.

Organization Name:	Wind Prosumer
Contact Name:	Steen
Date/Time of Interview:	4/4/12
1. Before you committed to generating electricity at home, what did you know about the opportunities available to you?	

- Saw an ad about new laws in Denmark
 - Run mill as a company; made it more feasible 2010
- 2. What made you decide to generate your own electricity?**
- Produce electricity by yourself
 - Gain some profit
 - Projected rise in energy prices in the future
- 3. How did you learn about generating electricity at home?**
- Mainly through the internet
 - Solar panels weren't very interesting (~June, 2010)
- a. Who did you seek information from?**
- Internet, some ads in the newspaper
- b. Did you find it difficult to learn about how one could generate electricity at home? If so, what challenges did you face, and how did you address them?**
- Easy process; Choice between solar and wind
 - The retailer for the wind turbine made it easier. Independent research helped a lot
- 4. How did you select the equipment you purchased?**
- Maintenance cost of the mill is very low.
- a. What benefits did you expect to receive?**
- Economic benefits.
 - If energy costs increase in the future, then we wouldn't be affected.
- b. Who did you purchase your equipment from?**
- EcoWind
- c. What challenges did you face when selecting a system to install? How did you address them?**
- Very straightforward process. They prepared all of the papers; just had to send it to the government. 6-8 weeks to get paperwork back.
- 5. Who installed your equipment?**
- EcoWind
- a. Why did you select this particular installer?**
- The design of the turbine; few moving parts. Low maintenance.
- b. How long did the installation take?**
- 2 days
- c. How much did the installation cost?**
- 270,000 DKK
- d. What challenges did you face when having your equipment installed? How did you**

address them?

- No; straightforward process

e. Overall, how difficult was it to have your equipment installed? Would you say it was easy, hard, or somewhere in between?

- Very easy.

6. What role did your utility play throughout this process?

- He worked with a local electrician to install some of the electrical equipment / wiring. EcoWind took care of everything else.

a. In what ways were they helpful?

- N/a

b. In what ways were they not helpful?

- N/a

7. How long have you had your equipment?

- Since 2010.

8. Now that you've had the equipment for a while, in what ways has it met and/or not met your expectations?

- Has met his expectations
- Some noise from the mill
- The mill has given amount of energy that was expected from the mill.
 - 10,000-11,000 kWh per year

9. Now that you have the equipment, have you changed your energy use behavior at home? How so?

- Switched to electric heating (with some wood in the winter months).

10. Would you recommend that others purchase similar equipment? Why or why not?

- Yes. The mill is performing as specified. A good product. The finances are working out as expected.

11. What would have streamlined the whole experience for you?

- Nothing much
- You had to send some information to Energinet; he did not know about having to do this.

12. If you were to purchase this or similar equipment again, what would you do differently with the knowledge you now have?

- Look at the additional wind turbines on the market; otherwise select the same turbine.

13. Do you have any neighbors who can speak English and might be willing to talk with us?

- Not really. People drop by to ask about it though.

Interviewee-Specific Questions

Did you talk to the utilities personally?

- EcoWind took care of talking to the utility.

Extra notes

- Suggested: Make some calculations to see what the payback time is using the different types of mills. Spreadsheets help with the cost calculations. Very important to have a reliable spreadsheet with all of the costs and tax information included, and projections for rising energy costs.

Organization Name:	Wind Prosumer
Contact Name:	Hans Madsen
Date/Time of Interview:	Email Response
<p>Type of Wind Mill:</p> <ul style="list-style-type: none"> • Wind Mill 22 kW, 3 winged, swept area of 88 square meters • 18 meter tower. Produces medium-location <p>When the wind mill was set up, annual production:</p> <ul style="list-style-type: none"> • The mill was put into operation on 11-12-1981 • Annual production from 24,000 kW to 44,000 kW with average over 30 years = 32000 kW <p>1. Before you committed to generating electricity at home, what did you know about the opportunities available to you?</p> <ul style="list-style-type: none"> • Through ads and conversations with other mill owners <p>2. Did you find it difficult to learn about how one could generate electricity at home? If so, what challenges did you face, and how did you address them?</p> <ul style="list-style-type: none"> • Authority treatment (taxes?) • Getting a connection to the grid • Turbine size, type, and make <p>3. What made you decide to generate your own electricity?</p> <ul style="list-style-type: none"> • Consumption in 1981 for electricity and oil total of 32000 kW. • “With rising energy prices and taxes, I thought alternative energy” <p>4. What benefits did you expect to receive?</p> <ul style="list-style-type: none"> • I expected that the turbine power generation would cover 65% of energy and the rest of electricity sold to the utility grid. <p>5. How did you select the equipment you purchased?</p> <ul style="list-style-type: none"> • I chose a simple and robust construction and something I could repair and convenient to maintain itself. <p>6. Who installed your equipment?</p> <ul style="list-style-type: none"> • Manufacturer, Elianstøren and myself. <p>a. How long did the installation take?</p>	

<ul style="list-style-type: none"> From the casting of the foundation for the mill was probably about 30 days <p>b. How much did the installation cost?</p> <ul style="list-style-type: none"> My charge for foundation, grid reinforcement and the mill total 205,000 KR <p>7. Now that you've had the equipment for a while, in what ways has it met and/or not met your expectations?</p> <ul style="list-style-type: none"> The mill has largely honored my expectations. <p>8. If you were to purchase this or similar equipment again, what would you do differently with the knowledge you now have?</p> <ul style="list-style-type: none"> N/a

Consumers

Organization Name:	Consumer
Contact Name:	Susanne
Date/Time of Interview:	4/20/12 13:10
<p>1. Are you aware that you could generate electricity at home with solar panels?</p> <ul style="list-style-type: none"> Yes <p>a. What is your general impression of opportunity?</p> <ul style="list-style-type: none"> Good impression. Not planning to do it; too expensive up front. <p>b. Have you heard about this opportunity before? If so, how did you learn about it, and what do you know?</p> <ul style="list-style-type: none"> Yes; from her neighbor. <p>2. How much do you think installing solar panels would cost? We don't need an exact or a correct answer, just estimate based on what you know.</p> <ul style="list-style-type: none"> Absolutely no idea. Guessed 100-200,000 DKK. <p>3. Have you considered installing solar panels on your home?</p> <ul style="list-style-type: none"> Have not considered it; just recently moved. Don't have the money <p>a. If you were to consider or have considered installing solar panels, what type of benefit would be most interesting to you? Some examples are saving money, reducing environmental impact, less dependence upon the electrical grid, etc.</p> <ul style="list-style-type: none"> To save money <p>b. If you were to consider installing solar panels, how much money would you be willing to spend on solar panels up front?</p>	

- Needs more information.

c. If you were to consider installing solar panels, within how much time would you expect the system to pay for itself?

- Would hope within 5 years, more like 10 years. 5-10 years.

d. If you have already considered installing solar panels on your home, why did you choose not to purchase a system for your home?

- Did not consider; too expensive.

Interviewee-Specific Questions

Have you heard about installing solar panels from anyone else than your neighbors?

- Basically from them; and the neighborhood

If you were to consider installing solar panels, how would you prefer to learn more about it?

- Sending some simple materials like brochures, etc.
- Step 2, go to a meeting, talk to someone about it
- Lots of examples.

Organization Name:	Consumer and EcoGrid
Contact Name:	Maja
Date/Time of Interview:	04/23/12 08:30
<p>1. Are you aware that you could generate electricity at home with solar panels?</p> <ul style="list-style-type: none"> • Yes. <p>a. What is your general impression of opportunity?</p> <ul style="list-style-type: none"> • Doesn't really like the regulations in Denmark for generating your own electricity • Net metering strains the distribution company; lost tax revenue • Thinks they will change this legislation; does not know what will come instead • Payback time of around 10 years <p>b. Have you heard about this opportunity before? If so, how did you learn about it, and what do you know?</p> <ul style="list-style-type: none"> • Yes. Led the EcoGrid project. <p>2. How much do you think installing solar panels would cost? We don't need an exact or a correct answer, just estimate based on what you know.</p> <ul style="list-style-type: none"> • No Response <p>3. Have you considered installing solar panels on your home?</p> <ul style="list-style-type: none"> • Yes, considered solar panels and small wind, but decided not to pursue the opportunities until the net metering policies were changed so she could consider payback period. 	

- a. **If you were to consider or have considered installing solar panels, what type of benefit would be most interesting to you? Some examples are saving money, reducing environmental impact, less dependence upon the electrical grid, etc.**
 - No Response
- b. **If you were to consider installing solar panels, how much money would you be willing to spend on solar panels up front?**
 - No Response
- c. **If you were to consider installing solar panels, within how much time would you expect the system to pay for itself?**
 - No Response
- d. **If you have already considered installing solar panels on your home, why did you choose not to purchase a system for your home?**
 - No Response

Interviewee-Specific Questions

You installed heat pumps; what was the decision process for that?

- Old oil boiler with a tank \geq 40 yrs old
- Needed to replace; considered a wood pellet stove
- Heard from her father that it was too much work; he had two colleagues who had installed it, and it was very convenient.
- Also allowed her to get rid of the chimney, boiler, and tank

Have you considered installing solar heating?

- Needs to make sure that you can actually use the hot water. If the water boils, then it ruins the solar thermal tubes.
- Needs more maintenance than photovoltaics or a wind turbine

Can you tell us a little about the EcoGrid project?

- It's a smart grid project. "They have the day ahead market." What people will use, and what people will make in these hours. Sometimes, it doesn't match, because of breakdowns or the wind prognosis isn't right. Also, the regulating power market; to participate, minimum capacity is 10 MW. Energinet has to call additional suppliers and get them online.
- The goal is to turn this around; set a price 15 minutes ahead, see what responds. Consumers may choose to stop consumption, producers may choose to start production. Price is changed every 5 minutes. 5 minute intervals match appliances.
- She fears that people will get a picture that they need to get up in the middle of the night to start their appliances.
- Partners with the Danish Consumer Council to inform consumers; they need a lot of help, "almost education". > 2000 participants in the EcoGrid project. The question is how to maintain the change.
- Lots of small consumers are interested. Larger consumers are not as flexible in their usage due to business processes and lack of automation.

In your interactions with the participants, what was the most effective way to motivate people to participate?

- “We have a lot of media [on Bornholm].” Local news station, radio, newspaper. Bornholm has a lower education level and income than the average of Denmark; despite that, they are aware of the nature and conscious of the nature.
- On one hand, they have low education and income, on the other hand, people are aware of nature. Opened a demonstration house right next to a building hardware supply store. Had media events, open house; 300-400 people visited the demonstration home.
- “It’s very important not to disappoint potential participants.” They weren’t as ready as they thought when they opened the demonstration house.

EU is funding the project

- 7th framework program project. 7th framework is a research funding program. They have requested to have some demonstration on the smart grid.
- Their challenge is to handle wind turbines; a primary motivator for the project.
- Three strategies for incorporating wind: smart grid, interconnections with neighboring countries, storage. Methane storage.
- Dong has a similar project; E-Flex. 120 participants in the Copenhagen area

You mentioned that the current regulations for wind and solar PV production will not work well for the future. What do you envision as a more appropriate regulation framework that would fit with the smart grid aspirations?

- Solar and wind must always produce as much as possible; “that’s not a real market”. People lose money if they produce too much and there’s no one to buy the energy.
- Net metering was instituted as a quick fix; and easy way to do it. Some losses from tax, some losses in energy income, but it was too little to notice [1990’s]. Now, it’s a much bigger problem.
- We had an energy minister who thought that electric heating was very bad. Electric heating consumption is timed at 250%. Where district heating is available, this is okay. In the countryside, without district heating, why not? Especially since electricity is becoming much more renewable.
- “They need a regulation to enforce it” in order to achieve the government energy goals for the future.

Are heat pumps affected by the penalties against electric heating?

- No. Only direct electricity to heat.
- “If they had the right regulations, people would install heat pumps, because they are so efficient.”
- The right regulation, and a lot of information would help change their behavior.

The taxes discourage people from using electricity for heating, when one could be much more efficient by using electricity?

- Very good for society. People would have a little buffer capacity in the home; use the buffers to store heat when energy is cheap.
- House has poor insulation; only keeps 18 degrees Celsius in the winter on heating alone. The idea is that in the winters, the immersion heaters should be on. But because of higher energy prices, they don’t use the immersion heater.
- The smart grid would allow people to be more flexible in their usage; i.e. she would use the immersion heater with a buffer tank.
- District heating is not available for her home.

Extra Notes

- Grew up with two wind turbines at home

- Large generator powered the home
- Small generator powered was connected to the grid
- Total of 20 kW

Non-Government Organizations

Organization Name:	The Ecological Council
Contact Name:	Søren
Date/Time of Interview:	4/18/12 10:00
<p>1. What is the mission of your organization?</p> <ul style="list-style-type: none"> • Main purpose – political influence and adjustments • Member based NGO working in various fields (Approx. 1000 members) <ul style="list-style-type: none"> ○ Participation in EU directives ○ Energy savings, taxes, etc. ○ Working at an higher level with corporations and organizations ○ Works with Green Peace, WWF ○ Velux, a big Danish wind producer ○ Danish transport authorities; biogas + electric vehicles ○ High vehicle registration taxes <p>Where do you seek funding from?</p> <ul style="list-style-type: none"> ○ Energi Fund created in 2004 - 2015; Energy companies have to contribute to the fund in order to “gain something from the organizations” <p>2. What group(s) of people does your organization focus on?</p> <ul style="list-style-type: none"> • Not usually directly involved with consumers • Net metering - Very successful; PV installations booming • Too successful - Lots of mistakes; people don’t ensure that their roof can support the panels • No independent testing of solar cells in order to tell consumers which panels are the best <ul style="list-style-type: none"> ○ Flaws - almost impossible for people in multifamily houses or people in apartments ○ Requires that every PV is connected to a consumption; people have to have wires connected to their own meters ○ Trying to transform to a Feed in tariff; no dependency on the meters and separate consumption <ul style="list-style-type: none"> ▪ Working with PV association and DEA to devise a proposal ▪ To help achieve energy strategy 2050 goals, people need things that they can do themselves <p>Did you hear about the independent organization that will be closed in October?</p> <ul style="list-style-type: none"> • Go Energi • Certified equipment and technicians; but did not provide the necessary information <ul style="list-style-type: none"> ○ Tasks will be absorbed by the DEA, and open to political strife <p>3. Does your organization encourage people to install solar panels on their homes? Why or</p>	

why not?

- Yes - Something ordinary people can do
- People become aware of their energy usage when they install panels
- People choose smaller installations than their usage because of the price signals

If so, how do you encourage or otherwise help people to become involved?

- N/a

4. What kinds of people usually contact your organization? Why do they contact your organization?

- Little direct contact with consumers
- Work with political organizations and low energy building organizations
- Work at a higher level; skilled people, political organizations, architects, etc.
- Give presentations at climate events
- Solar heating is not promoted much; very cheap
 - Cost effective outside of district heating areas
 - Want like to see more solar heating campaigns
 - Save biomass for the winter time and use solar in the summer

5. Can you recommend any other people or organizations that would be knowledgeable about residential solar panels?

Danish Energy Association Richard Shalborg	Danish Building Association Camila Damsoee	Energy Service Denmark Carsten Sohl	Tekniq Soroen Iase
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6. Do you know of any people who have had solar panels installed on their home who we could interview?

- N/a

Interviewee-Specific Questions**Does your organization recognize trends in PV installations?**

- PV is booming; people see it as an investment against increasing energy prices
It would force:
- People to think about their energy usage
- They will be exposed to the time price signals for electricity, which they are not at the moment
 - Net metering effectively provides a variable price feed in tariff
- They would like to see people with heat pumps also install hot water tanks, to allow them to be flexible as to when they use energy (i.e. as electricity prices change)

How long ago did you start promoting a fixed feed in tariff?

- About 3 months ago
Problem with booming interest in PV means loss of government revenue
- People in multi-dwelling apartments/collectives is almost impossible in collective buildings
- Installations would be a lot cheaper without the separate meters

Do you think the tariff program you propose will happen soon?

- It will take a while. People see solar panels as a good investment at the moment; it protects you against rising energy costs
- A feed in tariff would disturb that a little bit. An installer organization is against this, because they see it as energy savings and not as production. Different paradigm

What feed in tariff do you propose?

- Declining rate: 2 DKK 1st year, 1.5 2nd year, etc. Only for private investors. Business and public investors should be lower in the beginning.
- Businesses aren't as interested in PV, because they are exempted from electricity taxes already. This would help

If people install solar panels now, and a feed in tariff is instituted later, when would they have to switch?

- It depends. The Danish way is to ensure that people get their money back In the investment first. Maybe after 20 years or something.

Extra notes

- Main advice for summer homes: use solar water heating
- Definitely against small wind turbines
 - 43 ore Feed in tariff already
 - Micro wind now included in net metering 2 yrs ago
 - Too costly
 - Not aligned with consumption
- Solar panels produce during the day
- Economically:
 - Solar heating is the best
 - Solar PV is good
 - Micro wind is poor; no need to subsidize small wind turbines
 - Near cost turbines have a .73 DKK / kWh feed in tariff
 - As big wind turbines arrived, not as many ordinary people are investing in large scale wind turbines
 - Eco Council would rather have pore individuals involved in large turbines

Organization Name:	PV Owners Association
Contact Name:	Arne
Date/Time of Interview:	04/17/12
1. What is the mission of your organization? The vision <ul style="list-style-type: none"> • Independent and updated knowledge dissemination in relation to people who have invested, but also for people who are considering investing in solar cells. To carry out the private photovoltaic your interests to: • Government and parliament • Manufacturers and wholesalers 	

- Installers
- Research development and licensing institutions
- Electricity Supply Companies

The association will work through:

- Arranging meetings for members of the society where we can share experiences
- To arrange lectures by competent key staff - technical, administrative and political.
- To influence decision makers to ensure transparency in the approvals and authorizations.
- To protect its members' economic interests.
- To build network with relevant institutions and individuals

2. What group(s) of people does your organization focus on?

- (See above in Vision)

3. Does your organization encourage people to install solar panels on their homes? Why or why not?

- Yes, they also advocate for solar panels to utilities, installers and RD institutions

a. If so, how do you encourage or otherwise help people to become involved?

- A large amount of information, including general facts about solar panels, installation processes and helpful web links. There is a general guide book provided on their website that including what Net Metering is, what the grid is, how Energinet.dk works, types of installations, installation forms and requirements, and what kinds of manufacturers are available.

4. What kinds of people usually contact your organization? Why do they contact your organization?

- People tend to contact the organization asking about recommendations on purchasing solar panels and recommending installers and suppliers. They are working with Tekniq, a trade and industry organization to create a common guide.

5. Can you recommend any other people or organizations that would be knowledgeable about residential solar panels?

6. Do you know of any people who have had solar panels installed on their home who we could interview?

Organization Name:	Energy Service Bornholm
Contact Name:	Mikkel
Date/Time of Interview:	4/24/12 14:30
1. What is the mission of your organization? <ul style="list-style-type: none"> • Giving advice, makes campaigns to help people switch to renewable energy sources and use energy more efficiently in the home • Provides an advice service; part of a national network 	

- Provides independent advice
 - Works closely with companies that install the equipment, but still independent
- 2. What group(s) of people does your organization focus on?**
- Consumers.
- 3. Does your organization encourage people to install solar panels on their homes? Why or why not?**
- They try to list some of the things that people should be aware of; some good, some bad
 - They provide general information, and then refer them to installer organizations
- a. If so, how do you encourage or otherwise help people to become involved?**
- See below. Question #4
- 4. What kinds of people usually contact your organization? Why do they contact your organization?**
- Some straightforward questions; i.e. can you recommend a company
 - Others ask about prices
 - Tax/legislation concerning solar panels.
 - What people can do with their roof; local rules
 - Lots of basic questions; how much space, direction, etc.
- 5. Can you recommend any other people or organizations that would be knowledgeable about residential solar panels?**
- Center for Renewable Energy in northern Jutland
 - They put together some reports about small wind turbines
 - It's difficult to give people advice about the small wind turbine
 - Very few reports about what is good and what is bad
 - A lot of them are too small; they are not high enough for them to work well
- 6. Do you know of any people who have had solar panels installed on their home who we could interview?**
- N/a

Interviewee-Specific Questions

Do you focus on a particular type of green energy?

- Primarily on solar panels.

When you say campaigns, what do you mean?

- It's campaigns focusing on private households by advertising in newspapers, local TV
- Info meetings at someone's home who already has panels
- Help people learn from others' examples
- Had a strong campaign; 7-8 info meetings, 40-50 people attended each
- They work with local journalists

Have you heard about Go' Energi's funding cut?

- In many ways, they do much of the same work
- But they had 8-10x bigger funding; Energy Service Bornholm works with local projects

- Funding allocation in the recent political agreement is not what it should be

Do you refer interested people to local installers?

- Yes. They have a list of 18 companies that know about PV tech.

Will you make house calls?

- No; not enough resources to visit everyone. Some projects are financed, and they can visit people.

Do you know about the projected net metering costs?

- They know that there will be more costs for Ostkraft as the popularity goes up.
- It's very difficult to answer these kinds of political questions.

Other countries do a fixed FIT; would this work in Denmark?

- It's very economical as it is in Denmark right now
- It's difficult to see how things will change

How long have you worked at Energy Service Bornholm?

- Since 2007.

Have you noticed changes?

- Yes. Big, big changes.
- In the past few years, 10 PV projects on Bornholm (not sure that I recorded this correctly).

What kinds of challenges do consumers talk about facing?

- Very little overview about the different PV products
- Danish Institute of Technology does some quality testing
- If the product is recommended in the PV island project, then they say it's ok, otherwise, it's difficult to say
- Some people need information about the economy and taxes. It's difficult for them to advice people on the laws and tax regulations.

What is the most effective way of communicating with consumers?

- Very intensive campaign; lots of meetings
- Lots of one-on-one meetings; 9 info meetings with people who have installed it already
- No scientific information about which method works best though

Government Organizations

Organization Name:	Go Energi/Exergi
Contact Name:	Goran
Date/Time of Interview:	04/20/12 11:00
1. How does home electrical energy generation fit into the nation's energy strategy? <ul style="list-style-type: none"> • The government should give subsidies to the consumer 	

- If prices go up, then the subsidy would stop
- This didn't happen in Germany; the subsidy went to the industry

You see the solar panel as a way to promote the government's green agenda by giving them something they can have, it's a new gadget?

- Yes. There used to be super computers; now, people have their own. It became personal.
- You have your own car
- "You have to have something personalized which is connected to the global policy"
- "it's good for me, my family, and the rest of the world"

2. Has any work been done to analyze the opportunities for home electricity generation as a significant source of energy?

- No Response

3. What types of incentives are currently offered to people to generate electricity at home, and what kinds are being considered for future implementation?

- No Response

4. What are the most successful ways to influence consumer behavior, specifically in the energy sector? For example, what kinds of incentives or benefits are most successful?

- Secondary question: What do you envision as the ideal tariff scheme?
 - "Very afraid of giving subsidies to the investment"
 - The price could be too high; benefits the companies who develop it
 - Subsidies may the economy for a product look better than it really is
 - Much better to make non-commercial tests of equipment; they help sell things
 - If you give subsidies, it's because you want to transform the market.. without legislation, you doing it as a free agreement
 - Avoid making the industry lazy
 - People like independent quality labeling; it makes it easy for consumers to see which ones are good
 - It's very hard to stop a subsidy period
 - Figure out how to stop the subsidies; "the last day is always a disaster"
 - Take all of the central products that you want to improve
 - Figure out what are the most important things
- For light bulbs,, it was information
 - Made tests, show that they could last as long as they claimed
- Could they make something to help with the prices
- Sell heat pumps with an internet connection; experts can measure the systems and guarantee how well it will work for someone

Interviewee-Specific Questions

What are your thoughts about the funding cuts to Go Energi?

- Before it was Go Energi, it was the Danish energy savings trust
 - Sometimes they went against the energy ministry
 - They were on the consumer side
 - The politicians disliked them
 - Politicians got rid of them and moved it into the government
- "It's not always about the climate goals, it's about resources"
- The bureaucracy is very much protective of their own interests
- The DEA thinks its impolite to post bad press about cheating on labels

- Energy Savings Trust pushed very hard against industry players
- DEA would rather fine them
- The idea of closing Go Energi was introduced in the last two days of a big deal between parties
- Go Energi divided legislation and industry, the DEA does not

Extra notes

- Energy labeling is tough to change over the years; too many products get an A rating
 - They have to be careful to adjust the ratings appropriately
- Lots of people say that people are prepared to pay a little bit more for green energy
 - What people say is not automatically what they do
 - “If it’s easy to act the right way, it is a fair economy”
 - If it is difficult, or expensive, or costs much more, then you won’t do that
 - “If it’s difficult to get information, then you are not green in action”
- They need to sell heat pumps to achieve the energy policy they want
 - People are not as interested; government wants to sell them to reduce oil/ fuel usage
 - People are very interested in solar; government doesn’t care as much because of wind electricity
 - “it’s easy...it’s a very short story” talking about solar
- It should be a short story to do something
- There needs to be a personal aspect to move forward, “personalized, that fits with government policy”
- “In 2 years, I think people will say it’s old fashioned” about installing solar panels
 - But right now, it is very popular
- “it should happen something in your neighborhood.. you should be a part”
- “communicate to make the consumer feel good”
- “It’s a side effect that when people install solar panels, they become very aware of their consumption”
- “If they’re not interested, they won’t support the government, and they won’t invest their money”
- Benefits
 - People are more responsible
 - If a private person decides to use \$20k on solar PV, the alternative would be a new car or new kitchen
 - It’s good when a private person invests in the energy economy; otherwise the government has to do it
- “involving the consumer not only at the green agenda, but also at the gadget agenda”
 - If you make it something people are proud of, then it’s easier to focus on the green agenda
- Germany
 - The subsidy program in Germany was too good; it caused an export of technology to china
 - Decreased subsidy by a large amount instantaneously, so local industries went broke
- His company want to remove the risk from installing pv panels
 - Guarantee the level of production from the panels after assessing the site
 - Some guarantee the monetary benefits as well
 - Sell the risks to a market player
 - The consumer wants security
- Doesn’t think small wind will work well
 - Can cause problems with neighbors
 - Neighbors can go to the government

- They should be on buildings outside of communities
- Real potential is solar, should be marketed as a gadget

Organization Name:	Danish Energy Agency
Contact Name:	Rasmus
Date/Time of Interview:	Phone Interview
<p>1. How does home electricity generation fit into the nation's energy strategy?</p> <ul style="list-style-type: none"> • Recent political agreement towards energy policy through 2020 • Residential power doesn't have a big role in that; not yet at least • For the individual consumer its important <p>2. Do you think that home energy generation will play a significant role in the nation's future energy supply?</p> <ul style="list-style-type: none"> • It's picking up pace. See Germany; it can become an important source of electricity • It's one of many important technologies <p>3. We have heard of incentive programs for home energy generation like net metering and financing equipment like a small business. Are these programs sustainable? Are you considering any other incentive programs for the future?</p> <ul style="list-style-type: none"> • No comment. <p>Interviewee-Specific Questions</p> <p>We have spoken with some people who have their own home generation equipment. Some of them have expressed interest in independent information about equipment and the opportunities available to them.</p> <ul style="list-style-type: none"> • No current plans. Would be helpful, but don't have the resources to provide that information. <p>We know that GoEnergi and the Danish Energy Savings Trust before it provided some independent equipment rating and advice to consumers. Will this be continued somehow?</p> <ul style="list-style-type: none"> • May be distributed to Energi Service Denmark. Some of their work may not be continued. 	

Equipment Manufacturers and Installers

Organization Name:	EcoWind
Contact Name:	Carsten
Date/Time of Interview:	3/23/12 13:00
<p>1. What are the costs and the installation time for an average residential PV system or mini wind installation?</p> <ul style="list-style-type: none"> • 6 month Installation process, can install in one day (cost of 300,000dkk) 	

- Common installations: 6kW turbine
 - Smaller turbines at 1kW – use all the power in a year
 - Best investment is 6kW
 - Save 50% of investment in tax payment cuts (with 8-9 yr payback)
 - General process: PV in summer and wind in winter
 - 2/3 of yield in winter and 1/3 of yield in summer
 - Average of 20,000 kwh per year in wind (6kWh max)
2. **Do you collect consumer response/interaction data during or after the installation process? If so what kinds of data do you collect, and may we view it?**
 - 3 months after customer, see if everything is working, collect data on customer use
 - React immediately when customer has problems
 3. **What type of installation do you most often perform?**
 - 6kW Wind Turbine; do not do any installations less than 6kW
 - Best investment
 - Each kW produced can be used or sold
 - No off grid energy in Denmark
 - Off grid equipment is expensive; no reason to have off grid in Denmark
 4. **What types of incentives or advertising do you use to entice consumers to buy from you?**
 - See below. Question #6
 5. **Are there any incentives for consumers with off-grid PV or wind to connect their PV or wind to the grid?**
 - No off grid installations
 6. **In general, what kinds of incentive programs or advertising have worked the best for your company?**
 - Website
 - Government incentive
 - Word of mouth
 - Inform Danish people at fairs (info sessions)
 - Councils and local area advertising
 7. **Does your company have any current plans to expand your incentive programs or advertising? If so, what kinds of incentives do you plan to use and why?**
 - N/a
 8. **Do you know of any consumers or consumer groups which would be willing to speak with us about their experiences using grid-contributing renewable energy technologies?**
 - Yes – given a wind prosumer contact

Interviewee-Specific Questions

How do the tax incentives work in Denmark?

What is the main reason you lose a customer?

- Price

Customer reactions:

- Customers usually farmers
- Some customers talk to municipality and they say no because of time
- Price is important (lost customers because of cost
 - Price can be hard for customer
- Some competitors in Denmark
- Have expensive equipment but very good equipment

Expected lifetime?**Extra Notes**

- Brand new in 2007 on wind incentives
 - First contact with Danish government about small turbine
 - 2008 work with government and get a tax cut
 - Sweden, Ireland, Germany work with larger turbines; interconnected with Ireland and Sweden and Iceland

Organization Name:	Living Energy
Contact Name:	Nicholaj
Date/Time of Interview:	4/3/12 11:00
<p>1. What are the costs and the installation time for an average residential PV system or mini wind installation?</p> <ul style="list-style-type: none"> • Planning process: get specific info from consumer <ul style="list-style-type: none"> ○ Roof angle ○ Annual power consumption ○ <u>Satellite views</u> ○ How old the roof & house is <ul style="list-style-type: none"> ▪ Static calculations for weight is an extra cost ▪ Most roofs are built for 80 kg of snow / m² • Install: 2-3 days • Planning: A couple hours • Complete package: 90,000- 150,000 DKK • Majority: 100,000-130,000 DKK <ul style="list-style-type: none"> ○ Package includes all equipment for a grid tie in, inverter, mounting, installation. <p>2. Do you collect consumer response/interaction data during or after the installation process? If so what kinds of data do you collect, and may we view it?</p> <ul style="list-style-type: none"> • Salesperson checks in on consumers; Only follow up <p>3. What type of installation do you most often perform?</p> <ul style="list-style-type: none"> • 1-2 residential houses a day • Also, deal in off grid installations 	

- Municipalities
 - Apartments: (Collaborative in apartment complexes are growing in popularity) – harder to do due to “gates” within the complex, more people collaborating so it takes more time
 - Owner boards are getting quotes
 - Just recently started
 - 6 kW inverter capacity per 100 sq. m of living space for net metering
 - Entrepreneurial companies
 - When they build a new building
 - In order to meet requirements (building codes)
 - BR 15, BR 20 limit max energy usage per sq. m in a home
- 4. What types of incentives or advertising do you use to entice consumers to buy from you?**
- 90% though Google hits (#1 in Denmark for “solar cell” in Danish)?
 - Partnerships with other companies (building companies (large and small), energy companies
 - Most people know a good amount before contacting Living Energy; they do research on their own
- 5. Are there any incentives for consumers with off-grid PV or wind to connect their PV or wind to the grid?**
- May be doing a large installation in Nigeria
- 6. In general, what kinds of incentive programs or advertising have worked the best for your company?**
- See above. Questions #4
 - Doesn't pay off to get systems that are larger than what is consumed
- 7. Does your company have any current plans to expand your incentive programs or advertising? If so, what kinds of incentives do you plan to use and why?**
- No. They leverage Internet searches and partnerships with other energy organizations.
- 8. Do you know of any consumers or consumer groups, which would be willing to speak with us about their experiences using grid-contributing renewable energy technologies?**
- He will send us an email with a potential organization and consumers may have to follow up

Interviewee-Specific Questions

How do the tax incentives work in Denmark?

2 Schemes

Net metering:

- Per kWh: people pay 60 ore for the electricity
 - Comes out to 2.2 to 2.4 DKK with taxes
 - Net metering pays you 2.2 to 2.4 back per kWh
- Calculated annually
 - Excess production per year is rated at 60 ore per kWh
 - After 10 years, excess drops to 40 ore
- Return on investment is 7-8 years (5 if run as small business)
- Most people mount on top of roof, some integrate
 - Costs more to do integrated
 - Looks a little more slick (integrated)
 - Integrated system loses 3-5% efficiency

- Mounted – can do write offs
- Integrated – can't do write offs (not considered a small business, it is part of the house)

Small business

- Mount on top of roof; cannot be integrated into roof
- Write of 25% of purchase per year from taxes
- 60 ore per kWh

What is the main reason you lose a customer?

- Price

Expected lifetime?

- Inverter: 15 years, need to replace 3x
- Panels: 45-50 years.

Extra notes

- Lots of time spent explaining incentives to consumers (2/3 to explain tax)
- Also time spent analyzing individual homes

Organization Name:	TEKNordisk
Contact Email Address:	Michael
Date/Time of Interview:	4/13/12 10:00
<p>1. What are the costs and the installation time for an average residential PV system installation?</p> <ul style="list-style-type: none"> • Depends on the size • 102-132,000 all inclusive (install and equipment), single person cheapest price <p>2. Do you collect consumer response/interaction data during or after the installation process? If so what kinds of data do you collect, and may we view it?</p> <ul style="list-style-type: none"> • They have a questionnaire that they encourage people to fill out; quality control questionnaire at installation part and the services they provide • Most common problems are communication errors; they have a strong policy about good communication • <u>It's very important that customers understand what they are trying to tell them</u> <p>3. Are these problems of technical nature, or tax incentives?</p> <ul style="list-style-type: none"> • <u>Both. Their biggest task is to narrow it down; they "cut it down to cardboard", i.e. explain it to the last detail.</u> <p>4. Do you have any statistics that you would be willing to share with us?</p> <ul style="list-style-type: none"> • No, not enough responses for statistics to be worthwhile. <p>5. What type of installation do you most often perform?</p> <ul style="list-style-type: none"> • <u>Energy optimization: Solar screening, automatic lighting control, heating/cooling, solar panel installation</u> 	

- Also install Uninterruptible Power Supplies
- Consulting for EU green company certification
- Most common: 6 kW; Many people also install heating pumps; these consume 6-7000 kWh/year
- Heat pump installation is growing in popularity

6. What types of incentives or advertising do you use to entice consumers to buy from you?

- Lots of financial information on the home page of website
- A newspaper is writing an article on energy optimization; TEKNordisk may be an expert for the article
- Google AdWorks brings a lot of calls; sometimes 8 hours / day of calls
- They make an agenda for the phone calls to save time
- Very informative website to save time

7. Are there any incentives for consumers with off-grid PV to connect it to the grid?

- (Unrelated) Bornholm Island monitoring places in Lyngby at Danish Technical University

8. In general, what kinds of incentive programs or advertising have worked the best for your company?

- Information on the homepage. Their competition doesn't make their homepage the same way
Most of their competitors' web pages are behind

9. Does your company have any current plans to expand your incentive programs or advertising? If so, what kinds of incentives do you plan to use and why?

- Newspaper ads
- Facebook; site under construction
- New installation trucks will serve as good advertisement
- Adds on the sides of installation projects (i.e. apartment complex installations)
- "Advertise everywhere"

10. Do you know of any consumers or consumer groups which would be willing to speak with us about their experiences using grid-connected renewable energy technologies?

- Will get back to us.

Interviewee-Specific Questions

Where do you get your panels?

- Produced in Germany

What is the most discouraging factor for customers?

- Price

When you're working with a potential customer, what do they have the most trouble with throughout the process?

- Private customers are usually quite informed and have done their own research beforehand

Extra notes

- Chinese government funds producers to offer lower prices and flood the market
- Tends to cause organizations to fail as prices fall

- People who purchase from them are unable to replace parts
- TEKNordisk appreciates a closer relationship with their supplier in Frankfurt
- IHC is good for home automation; a good start for smart grid integration
- Signaling is the biggest need at the moment; to get prices

Utilities

Organization Name:	DONG Energy
Contact Name:	Poul
Date/Time of Interview:	
Interviewee-Specific Questions <p>What is Dong energy's perspective on their customers installing wind turbines or solar panels?</p> <ul style="list-style-type: none"> • They try to be a green energy company; they like renewable energy sources • They are looking into how wind turbines and solar panels affect the grid • There are some concerns about voltage variations; they are studying the impact on the grid <p>What kinds of problems are you running into?</p> <ul style="list-style-type: none"> • Voltage fluctuations on feeders • The voltage profile is going in the wrong direction <p>Does the net metering scheme cause challenges for you?</p> <ul style="list-style-type: none"> • They get nothing for transporting energy on the grid <p>Is there a better policy you could suggest?</p> <ul style="list-style-type: none"> • Doesn't know what the policy should be; aware that there is some discussion on the topic, but doesn't know what it should be <p>We heard from a couple people about the E-Flex project; can you explain that?</p> <ul style="list-style-type: none"> • Going to be closed down • Investigating how much flexibility they could expect from the consumer • They are seeing a lot of popularity in heat pumps and electric cars • People may come home, plug in their cars, and start cooking at the same time in the evening • Load-shedding program allows them to postpone grid reinforcement • In what way would they persuade consumers to work as partners and consume energy at another time • Load-shed electric vehicles and stop heat pumps at the peak • Gave people a home automation system to monitor energy usage • Results: encouraged knowledge of energy usage • 5 consumer profiles: technical, economic, curious, benefit of society, simple benefit of society 	

What is the ideal energy grid structure? Do you envision a network of distributed energy sources?

- It's not a question of whether we like it or not; it is going to happen
- Their challenge is to figure out how to make it work

What is the political discussion?

- Mostly about price. As a monopoly, they're price to consumers is regulated.
- With the new developments, they have to ask 'who will pay for it?'

Extra notes

- Dong energy distributes energy below 10 KV; EnergiNet.dk handles the higher voltage level
- Monopoly; no one else can create a grid in their area
- They are in favor of renewable energy, but they have to figure out how to handle it in the future

Appendix D: Flyers and Outreach Materials

Ecowind Open house Session Advertisement:

Miljøpris 2011

EcoWind

Nu snurrer der endnu en mølle fra EcoWind

Så derfor vil vi gerne invitere til

ÅBENT HUS

Søndag d. 22 april kl. 14.00-16.00,
Salenevej 6, 3760 Gudhjem

Der vil være mulighed for at se en mølle på tæt hold og tale med ejeren af møllen.

Med EcoWind's husstandsmølle , får man en solid og gennemtestet mølle, som giver CO2 besparelse og skattefradrag allerede første år.

Alle er velkomne og vi byder på en lille forfriskning imens vi viser møllen frem og fortæller om ideen bag projektet.

Kom og vær med til et par hyggelige timer - vi står naturligvis klar, hvis du skulle have spørgsmål.

*EcoWind A/S · Mestervangen 5 · 3230 Græsted · 7022 9040
Husstandsvindmøller til private og erhverv*

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